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ABSTRACT

Presented in this course guide are seven units of study focusing on: (1) animal identification; (2) environmental testing; (3) ecological concepts; (4) wildlife abuse, depletion, and extinction; (5) water pollution; (6) air pollution; and (7) nuclear energy and the environment. Each unit includes a general objective, followed by specific objectives correlated with a content outline, daily instructional strategies, references and materials, and evaluation methods. A suggested time sequence for the units is also provided for the 18 week course. It is indicated that the units on animal identification and environmental testing are to be taught in conjunction with each other, first if the course is taught during the fall semester and last if the course is taught during the spring semester. (JN)

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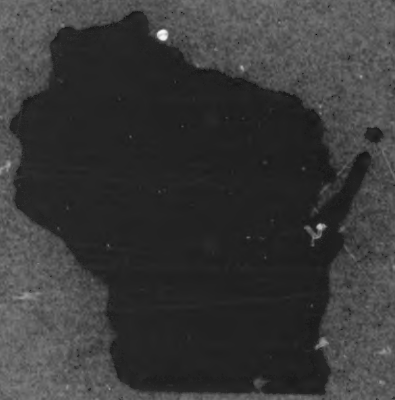

SCIENCE

CONSERVATION - ECOLOGY

BULLETIN NO. 341

JULY 1981

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SCIENCE

CONSERVATION -- ECOLOGY

July, 1981

By Julius Pellegrini

PREFACE

In an age when we are surrounded by many new scientific developments, all citizens should have an understanding of ecological concepts in order to better understand these changes. It is important that today's youth develop an understanding of science. The very survival of the human race may depend upon man's conservation of his ecology.

This is a one semester course designed to provide an opportunity to explore specific areas of ecology such as identification, environmental testing, ecological concepts, wildlife abuse, pollution, and nuclear energy.

This course guide was prepared by Julius Pellegrini of the Beloit Memorial High School Science Department.

William B. Heebink,
Director of Curriculum

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TIME SEQUENCE

ANIMAL IDENTIFICATION	5 weeks
ENVIRONMENTAL TESTING	
ECOLOGICAL CONCEPTS	3 weeks
WILDLIFE ABUSE, DEPLETION, AND EXTINCTION	3 weeks
WATER POLLUTION	3 weeks
AIR POLLUTION	2 weeks
NUCLEAR ENERGY AND THE ENVIRONMENT	2 weeks
TOTAL	18 weeks

UNIT I

ANIMAL IDENTIFICATION

OBJECTIVES

OBJECTIVE - UNIT I - The students will learn to recognize several animal species to enhance the study of ecology and to promote more interesting experiences when observing wildlife in their natural surroundings.

I. The student will learn to identify and name on sight 35 specified animals.

CONTENT OUTLINE

I. The following 35 animals will be identified as shown on slides:

1. Duckbill
2. Opossum
3. Armadillo
4. Beaver
5. Jackrabbit
6. Pangolin
7. Manatee
8. Aardvark
9. Shrew
10. Ape
11. Bat
12. African elephant
13. Pronghorn antelope
14. Zebra
15. Lynx
16. Harbor seal
17. Killer whale
18. Blue whale
19. Shark
20. Ichthyosaur (ancient sea monster)
21. Penguin
22. Seal
23. Salmon (example of catadromus fish)
24. Turtle
25. Dolphin
26. Eels (example of catadromus fish)
27. Tuatara
28. Lizard
29. Rattlesnake
30. Tortoise
31. Crocodilia

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. The students will be shown slides of 35 animals. A. The student will review slides until they can name each animal shown. B. This review will be a daily exercise until the students feel they are ready for testing. C. A short slide presentation on dangerous marine and terrestrial organisms will be shown.	Slide projector Animal slides Projected Learning Program, Inc. "Dangerous Marine Organisms" #55-301 "Dangerous Terrestrial Organisms" #55-303	A test will be given in which the student will identify each animal required.

10 11

51 11

OBJECTIVES	CONTENT OUTLINE
	32. Rattlesnake 33. Water moccasin (cotton mouth) 34. Copperhead — Poison destroys red blood corpuscles. Victim dies of suffocation from lack of oxygen to body cells. 35. Coral snake a. has a black head and resembles the non-poisonous milksnake b. poison affects the nerves

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13

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
14		15

OBJECTIVES	CONTENT OUTLINE
II. The student will learn to identify and name on sight 41 fish found in the Midwest.	I. These fish are the ones students can easily relate to since they are those that can be fished for and caught. A. The Sunfishes (FAMILY Centrarchidae): 1. Long-eared sunfish 2. Bluegill 3. White crappie 4. Pumpkinseed 5. Spotted sunfish 6. Rock bass 7. Largemouth bass 8. Smallmouth bass 9. Spotted bass B. The Perches (FAMILY Percidae): 1. Logperch 2. Yellowperch 3. Sauger 4. Walleye C. The Pikes (FAMILY Esocidae): 1. Northern pike 2. Great Lakes muskellunge 3. Little pickerel 4. Chain pickerel 5. Tiger muskellunge 6. Ohio muskellunge D. The Trouts (FAMILY Salmonidae): 1. Brook trout 2. Rainbow trout 3. Brown trout 4. Cutthroat trout 5. Lake trout E. The Salmons (FAMILY Salmonidae): 1. Chinook salmon 2. Coho salmon 3. Atlantic salmon
16	17

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. The 41 fish will be identified as they are shown on a screen using the opaque projector. A. The teacher will run the opaque projector as the students work on identification. B. Review of identification will be a daily exercise until the students feel they are ready for testing.	Opaque projector Pictures of fish stapled to stiff backing paper Booklet describing each group of fish	

18

19

OBJECTIVES	CONTENT OUTLINE
	F. The Sturgeons (FAMILY Acipenseridae): 1. Lake sturgeon G. The White Basses (FAMILY Serranidae): 1. White bass 2. Striped bass H. The Catfishes (FAMILY Ictaluridae): 1. Stone cat 2. Channel cat 3. Black bullhead 4. Yellow bullhead I. The Gars (FAMILY Lepilsosteidae) 1. Long-nosed gar J. The Suckers (FAMILY Catostomidae): 1. Greater redhorse 2. White sucker K. The Carp and Minnows (FAMILY Cyprinidae): 1. Goldfish 2. Carp 3. Creek chub 4. Golden shiner

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
		A test will be given in which the student will identify each fish required.

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GS

PS 23

OBJECTIVES	CONTENT OUTLINE
III. The student will learn to identify and name on sight 60 birds found in the Midwest.	I. The 60 birds will be identified as shown on slides and a short informational lab sheet will be filled out on each one. A. The following are the names of birds to be studied: 1. Robin 2. Crow 3. House sparrow English 4. Starling 5. Blue jay 6. American goldfinch 7. Common grackle 8. House wren 9. Barn swallow 10. Tree swallow 11. Bank swallow 12. Towee 13. Scarlet tanager 14. Black-capped chickadee 15. Sparrow hawk 16. Morning dove 17. Flicker 18. Eastern bluebird 19. Pileated woodpecker 20. Redwing blackbird 21. Chipping sparrow 22. Hairy woodpecker 23. Great blue heron 24. Mallard duck 25. Bob-white quail 26. Indigo bunting 27. Cowbird 28. American goldeneye 29. Bufflehead duck 30. Pintail duck 31. Meadow lark 32. Ring-billed gull 33. Eastern kingbird 34. Red shouldered hawk 35. Red tailed hawk
24	25

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. The student will be shown four series of 15 bird slides each for identification. A. The students will be able to review slides individually. II. The student will fill out a short informational lab sheet on each bird. A. The lab sheet will provide on each slide space for 4 bird information. B. Books from the library will be made available for this research. C. All lab sheets will be placed together as a booklet. III. For the final test the student will be able to snap identify each bird with only one second of observation.	Slide projector 60 slides of birds A copy of the lab sheet to be used can be found at the end of this unit.	The booklet of lab sheets will be turned in .

OBJECTIVES	CONTENT OUTLINE
	36. Cedar waxwing 37. Snowy owl 38. Canada goose 39. Baltimore oriole 40. Ruffed grouse 41. Wood duck 42. Red and white breasted nuthatch 43. Bald eagle 44. Red-headed woodpecker 45. Downy woodpecker 46. Catbird 47. Canvasback duck 48. Red-headed duck 49. Bobolink 50. Barn owl 51. Nighthawk 52. Great horned owl 53. Coot or mud hen 54. Cardinal 55. Ruby-throated humming bird 56. Song sparrow 57. Brown thrasher 58. Belted kingfisher 59. Red breasted merganser 60. Whooping crane

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
	References: Roger Tory Peterson, A Field Guide To The Birds Chandler, S. Robins, Birds of North America Bertel Bruun, Herbert S. Zim, Lester L. Short, Birds of the World Richard H. Pough, Audubon Western Bird Guide Ned R. Boyajian, Familiar Garden Birds of America Henry H. Collins, Jr., Herbert S. Zim, Ira N. Gabrielson, Birds Oliver L. Austin, Jr., Families Of Birds Ludlow Griscom, Audubon's Birds Of America Robert Porter Allen, On The Trail Of Vanishing Birds Walter E. Shultz, Bird Watching, Housing, and Feeding Alexander Sprunt, Herbert S. Zim, Gamebirds George J. Wallace, An Introduction To Ornithology Herbert S. Zim, Fishes Hurst H. Shoemaker, Carl L. Hubbs, Fishes Of The Great Lakes Karl F. Lagler, Region	The test will consist of snap identification. Only a one second exposure of a bird slide will be shown. All 60 bird slides will be involved.

ORNITHOLOGY

Name of bird: _____ Family: _____

Habitat:

When found in this area:

Food eaten: (When this information is available)

Identifying characteristics:

Name of bird: _____ Family: _____

Habitat:

When found in this area:

Food eaten: (When this information is available)

Identifying characteristics:

Name of bird: _____ Family: _____

Habitat:

When found in this area:

Food eaten: (When this information is available)

Identifying characteristics:

Name of bird: _____ Family: _____

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When found in this area:

Food eaten: (When this information is available)

Identifying characteristics:

ORNITHOLOGY

Name of bird: _____ Family: _____

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When found in this area:

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Identifying characteristics:

Name of bird: _____ Family: _____

Habitat:

When found in this area:

Food eaten: (When this information is available)

Identifying characteristics:

Name of bird: _____ Family: _____

Habitat:

When found in this area:

Food eaten: (When this information is available)

Identifying characteristics:

UNIT II

ENVIRONMENTAL TESTING

OBJECTIVES

OBJECTIVE - UNIT II - The student will determine conditions of the natural environment around Beloit Memorial High School by chemical testing of the air, water, and soil.

I. The student will be able to determine acidic and basic conditions using the pH scale.

CONTENT OUTLINE

I. Acids and Bases

A. What is an acid?

1. Acids are substances that contain the element H+ and easily release the hydrogen ions when placed in water.
2. Characteristics of acids:
   a. they are hydrogen (proten) donors
   b. they corrode active metals
   c. acids that are considered strong produce large numbers of H+ ions in water
   d. acids that are considered weak produce few ions in water
3. Some common acids are:
   a. hydrochloric acid (HCl)
   b. nitric acid (HNO_3)
   c. sulfuric acid (H_2SO_4)

B. What is a base?

1. Bases are substances that form hydroxide ions (OH^-) when dissolved in water.
2. Characteristics of bases:
   a. they form hydroxides in solution
   b. they attack animal and plant material
   c. bases are considered strong if they produce a great deal of (OH^-) ions in water.
   d. bases that are considered weak produce few (OH^-) ions in water
3. Some common bases are:
   a. sodium hydroxide NaOH also known as lye
   b. calcium hydroxide $Ca(OH)_2$
   c. ammonium hyrdroxide NH_4OH

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes II. General discussion with emphasis on what constitutes acids and bases. III. General discussion emphasizing the pH scale.	Overhead projector and transparencies	

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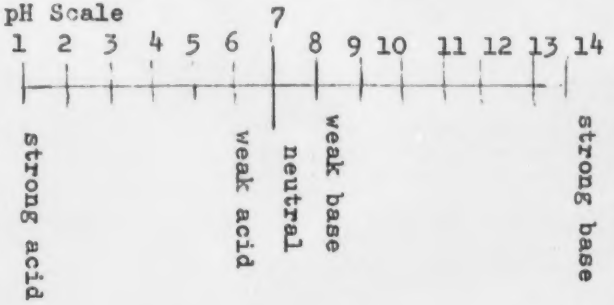
OBJECTIVES	CONTENT OUTLINE
	II. It is convenient to use the pH scale to indicate how acidic or basic a solution is. 1. The pH Scale  2. Approximate pH Value of Several Common Liquids a. lemon juice 2.3 b. vinegar 2.8 c. soft drinks 3.0 d. orange juice 3.5 e. milk 6.5 f. pure water 7.0 g. human blood 7.4 h. sea water 8.5 i. milk of magnesia 10.5 III. Hydrion paper is the most convenient method of determining pH in the field. A. Other chemical means of finding pH values will be explained.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
IV. Teacher demonstration of pH using several indicators.	Dilute hydrochloric acid (HCl) Dilute sodium hydroxide ($NaOH$) Watch glass A soft drink (should be clear like 7-Up or Team) Shampoo Litmus paper (red and blue) Hydrion paper Phenolphthalein	A quiz will be given to cover all materials to this point.

OBJECTIVES	CONTENT OUTLINE
II. The student will determine the water quality of Rock River and the Lagoon by using specific chemical tests.	I. The necessary materials and methods for detecting various common water pollutants will be found in the water pollution kit. A. The following common water pollutants will be tested for: 1. Ammonia nitrogen 2. pH 3. Chlorine 4. Chromium 5. Copper 6. Cyanide 7. Iron 8. Nitrate nitrogen 9. Phosphates 10. Silica 11. Sulfied II. The necessary materials and methods for determining dissolved oxygen will be found in the dissolved oxygen test kit. A. The amount of dissolved oxygen in water is dependent on several factors. 1. Wind action 2. Photosynthetic activity in the water 3. Turbulance of the water (water movement) 4. Oxygen demanding pollution 5. Temperature of the water 6. Others B. When water contains at least 8 parts per million of dissolved oxygen, the waters can support the following: 1. Trout 2. Black bass 3. Pikes 4. May fly larvae Stone fly larvae Caddis fly larvae

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Testing of Rock River water will be done once per week. A. The common water pollutants are listed. B. All lab sheets related to this work will be kept and a booklet formed. 1. Instructions for the booklet will be detailed to the students and will be included at the end of this unit.	"Qualitative Introduction To Water Pollution" kit Lab Aids No. 19 Lab sheets	The student booklet of environmental testing will be turned in when all testing is completed.
II. The student will leave the building and work along Rock River.		
III. The teacher will provide individual help when needed.		
IV. Testing of the Lagoon will be done only once.		
I. The testing for dissolved oxygen will follow the same pattern as described for common water pollutants.		The student booklet of environmental testing will be turned in when all testing is completed.
II. Lecture - students take notes	Hatch - Dissolved Oxygen Kit	
III. General discussion on the significance of the dissolved oxygen content of water.	Lab sheets Overhead projector and transparencies	

OBJECTIVES	CONTENT OUTLINE
	C. When water contains 2 ppm or less of dissolved oxygen it can support only the following: 1. No fish 2. Sludge worms 3. Midge larvae 4. Mosquite larvae 5. And other undesirable organisms III. Biological Oxygen Demand (B.O.D.) A. Aerobic decomposer organisms, microorganisms like bacteria, are constantly at work in water breaking down organic compounds into carbon dioxide and water. 1. Other bacteria convert ammonia and nitrites into nitrates. B. These processes, all of which require oxygen, are all natural components of biogeochemical cycles. C. If a body of water contains little organic matter then: 1. The aerobic bacteria can break down the organic matter without using a great deal of oxygen from the water. 2. Oxygen is replaced by natural means without upsetting the natural oxygen balance. 3. The biological oxygen demand (BOD) is low indicating a great deal of dissolved oxygen will be present.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes	Overhead projector and transparencies	
II. Hand out charts and diagrams	Handouts will be located at the end of this unit.	
III. The teacher will demonstrate how the BOD of water is determined. A. This demonstration will be five days in length. B. The student will take readings from the apparatus. 1. The chart developed will become part of the student booklet of environmental testing.	Educational BOD Respirometer, Hach Chemical Company Hach BOD Data Chart	The student booklet of environmental testing will be turned in when all testing is completed.

OBJECTIVES	CONTENT OUTLINE
	D. If a body of water contains massive quantities of organic matter then: 1. The population of aerobic decomposer bacteria multiplies due to the quantity of food. 2. A serious oxygen shortage develops as the bacteria consume the organic matter. 3. The biological oxygen demand (BOD) is high resulting in a lower quantity of dissolved oxygen. E. This condition of high concentration of organic matter occurs naturally in: 1. Swamps 2. Marshes 3. At the bottom of stagnant ponds and lakes F. The action of aerobic bacteria on a rich source of food of ten reduces the dissolved oxygen (D.O.) level to zero. 1. When this happens, anaerobic bacteria take over as the main decomposers and putrefaction sets in. 2. Whereas aerobic bacteria produce odorless water and carbon dioxide, anaerobic bacteria produce gasses like methane (CH_4) and hydrogen sulfide (H_2S)--hence the awful smell. G. Man is creating anaerobic conditions in many bodies of water. 1. Untreated or poorly treated effluent from sewage treatment is one source. 2. Also pulp and paper mills cause anaerobic conditions when untreated waste is dumped into streams and rivers.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
53		54

OBJECTIVES	CONTENT OUTLINE
	IV. Suspended Solids Determination A. This investigation is designed to determine the concentration of suspended material in water in ppm. 1. The sources of suspended solids: a. algae b. silt c. suspended organic matter d. dissolved organic compounds e. dissolved solids B. The clarity of the water depends a great deal on the amount of suspended solids. V. Acid Rain Determination A. This investigation is designed to determine how acidic water becomes from atmospheric pollution as it falls as rain. 1. The acid rain develops usually from concentration of sulfur dioxide which originate in burning sulfurous fuels. 2. Other sources of this gas are natural decay and volcanic eruptions. B. The sulfur dioxide (SO_2) combines with moisture to produce sulfuric acid H_2SO_4. $SO_2 + H_2O = H_2SO_4$ sulfur dioxide + water — sulfurous acid $SO_3 + H_2O = H_2SO_4$ sulfur trioxide + water — sulfuric acid C. These acids fall over the countryside as acid rain.
55	56

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes	Overhead projector and transparencies	
II. General discussion with emphasis on accurate work with balances.		
III. Discussion of laboratory work on suspended solids A. Rock River water will be used. B. The results will be calculated in parts per million	Equipment needed: Alcohol burner 100 ml beaker burner stand graduated cylinder watch glass scale	
IV. The lab sheets will become part of the environmental testing booklet.	The lab sheet needed is included at the end of this unit.	The student booklet of environmental testing will be turned in when all testing is completed.
I. Lecture - students take notes	Overhead projector and transparencies	
II. General discussion dealing with accuracy of laboratory work. A. The rain water will be collected at the homes of each student in order to achieve a sampling in many areas of Beloit. B. The actual pH testing will be done in the laboratory.	Equipment needed: one baby food jar a map of Beloit to show where the rain has been collected hydrion paper to determine pH The lab sheet needed is included at the end of this unit.	The student booklet of environmental testing will be turned in when all testing is completed.

OBJECTIVES	CONTENT OUTLINE
	VI. Particulate Count of Air Determination A. This investigation is designed to determine the number of particles that are airborne in a certain location. 1. In large cities such as Montreal, New York, Chicago, or Toronto each breath taken in carries about 70,000 solid particles into the lungs. B. The sources of airborne particles are: 1. The chimneys of the world 2. Fly ash 3. Forest fires 4. Volcanic eruptions 5. Concentrated industries
59	60

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes	Overhead projector and transparencies	
II. Instructions for laboratory work on finding the particulate count in our building.	Equipment needed: clear glass slide scotch tape binocular microscope	
A. Constructing the slide counter will be done according to the laboratory sheet.		
B. The information on various conditions will have to be collected and reported as instructed from lab sheet.	The laboratory sheet needed is included at the end of the unit.	
C. The prepared slides will be placed in various locations in and outside the building.		
D. The actual particulate count will be done with the binocular microscope.		
III. The lab sheet will become part of the student booklet of environmental testing.		The student booklet of environmental testing will be turned in when all testing is completed.

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FORMULA-2533™ NITRIFICATION INHIBITOR

For Biochemical Oxygen Demand Tests

WATER ANALYSIS

A valuable new tool is now available to the BOD analyst. The tool—a convenient, yet very effective, nitrification inhibitor which is not biodegradable within the limits of the BOD test and does not affect carbonaceous oxygen demand.

To the BOD analyst, this means a more accurate evaluation of the effectiveness of wastewater treatment processes and a way of calculating potential nitrogenous oxygen demand.

WHY IT IS NEEDED

Measurement of total BOD has been and is being used for evaluating the quality of the wastewater treatment plant effluents, but when it comes to appraising the capacity and performance of the treatment process, the results may be inadequate if a significant amount of nitrifying bacteria is present. Since nitrification can occur sporadically and in varying degrees, greater confidence in the treatment evaluation would be gained if some means of nitrification control were used.

Another advantage in knowing the amount of oxygen demand due to nitrification is its use in predicting oxygen needs subsequent to the normal BOD test period. By correlating information on nitrogenous oxygen demand with data on ammonia and nitrite nitrogen levels, the effects of continued nitrifying can be ascertained.

THE BEST WAY

Nitrification control can be accomplished through sample modification techniques such as pasteurization and acidification or with chemical additives. By far the most convenient method, and the method with the fewest undesirable aspects, is with chemicals. A study by Young[1] concluded that:

1) Nitrification can be controlled much more rapidly and effectively with chemicals.
2) A concentration of 10 mg/l of 2-chloro-6-(trichloromethyl)pyridine completely inhibits nitrification when measuring the 20°C BOD of domestic wastewater samples by either respirometric or dilution methods and does not affect the carbonaceous oxygen demand.
3) Nitrification control should become a routine practice when measuring the BOD of all wastewater and natural stream samples, and supplementary ammonia and nitrite nitrogen data should be reported so that potential nitrogenous oxygen demand can be calculated.

[1]Young, James C., "Chemical Methods for Nitrification Control," presented at 24th Purdue Industrial Waste Conference, Purdue University, May 1969.

HOW IT IS USED

If only a measure of carbonaceous BOD is desired, BOD tests are conducted according to normal procedures except that a chemical inhibitor is simply added to each BOD test bottle.

If both carbonaceous and nitrogenous oxygen demand are desired, the measure of BOD then might be conducted in one of two ways. First, BOD measurement could be made with and without nitrification inhibitor, the difference in the two measurements representing the oxygen demand due to nitrification. Alternatively, a BOD test could be conducted using an inhibitor, and separate measurements of ammonia and perhaps nitrite nitrogen could be made. Separate measurements would permit calculation of the potential nitrogenous oxygen demand.

HACH FORMULA-2533 NITRIFICATION INHIBITOR

Hach Chemical Company is pleased to announce the addition of a nitrification inhibitor to their reagent product line. The Hach inhibitor uses 2-chloro-6-(trichloromethyl)-pyridine plated on an inert salt for ease of handling. The inhibitor, Hach Formula-2533, comes in a 35-gram bottle easily converted to a dispenser by merely changing the cap.

Formula-2533 is added directly to the wastewater sample by dispensing the powder in the empty bottle before the sample is introduced. For both the 157-ml sample used with the Hach BOD Apparatus and the 300-ml sample used with the standard dilution BOD test, one shot from the dispenser bottle (approximately 0.08 gram) is adequate.

HOW TO ORDER	Cat. No.	Price
Hach Formula-2533 Nitrification Inhibitor, 35-gram bottle less dispenser cap, enough for approximately 400 tests	2533-35	$5.50
Dispenser Cap, 0.05-gram delivery based on sodium chloride	459-01	1.30

T.M. Trademark of Hach Chemical Company

HACH'S SIMPLIFIED BOD APPARATUS AND PROCEDURES

Hach has overcome the largest previous objection to BOD analytical procedures with this new simplified method with no loss in accuracy. Now, a high degree of technical training, cumbersome procedures and complicated apparatus are no longer needed.

The mg/l BOD is read directly from the manometer scale. By using different sample volumes, various ranges may be selected from 0-35 to 0-350 mg/l BOD. No calculations, tables or extrapolations are required.

BETTER SAMPLING

The Hach BOD apparatus uses a larger test sample than the dilution method. This insures that a more representative result is obtained.

Since only a physical change is observed with the Hach BOD, the sample is not destroyed and a continuous curve of readings can be plotted. This gives a great deal of information about the nature of the waste.

RESULTS CAN BE OBTAINED IN HALF THE TIME

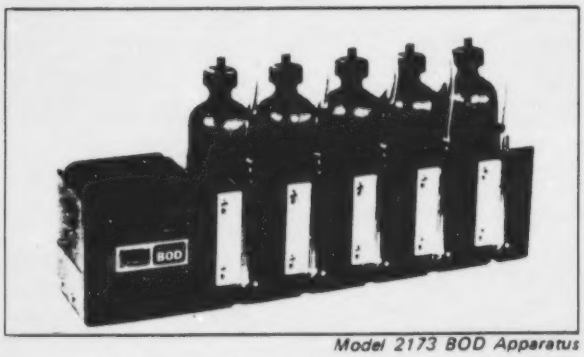
Using an incubation temperature of 35°C, a reading comparable to the standard 5-day, 20°C determination can be obtained in 2½ days.

NOT AFFECTED BY CHANGES IN BAROMETRIC PRESSURE

A closed-end manometer has been used in the Hach BOD which operates independent of any barometric changes. The system is freed of carbon dioxide by inserting a seal cup containing potassium hydroxide in each bottle. No buffers are necessary.

COSTS LESS TO BUY AND OPERATE

The cost of the Hach BOD apparatus is about the same as equipment for the dilution method, but is considerably less expensive in man-hours of operation.



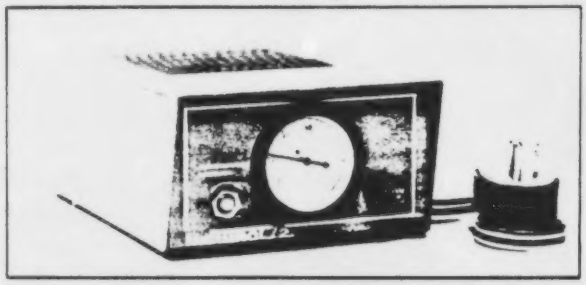
Model 2173 BOD Apparatus

PRICE Model 2173 BOD Apparatus
115 V, 60 Hz $250.00
220 V, 50 Hz 250.00

INCUTROL®/2 REGULATOR IS THE IDEAL COMPANION TO THE HACH BOD. CONVERTS AN ORDINARY REFRIGERATOR INTO A BOD INCUBATOR.

Because of the high costs of incubators usually required for Biochemical Oxygen Demand testing, many laboratories have been deprived of this vital testing apparatus.

Now, Hach offers a way to provide inexpensive incubation facilities for even the smallest laboratories. The Model 2597 IncuTrol®/2 Regulator converts an ordinary refrigerator, new or used, into a precision BOD incubator. It is also ideal for Coliform and other bacteriological incubation.



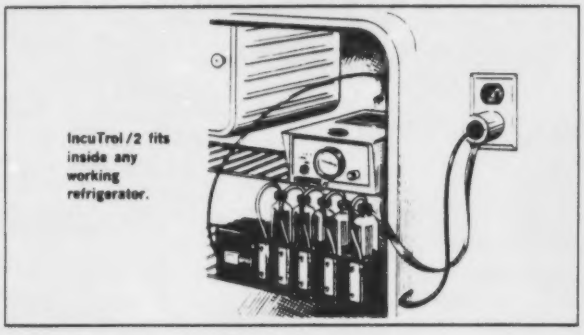
Model 2597 IncuTrol®/2 Regulator

FITS INSIDE ANY ORDINARY REFRIGERATOR

The IncuTrol®/2 Regulator is delivered ready to go . . . just plug it in and insert the refrigerator power plug into the back side of the regulator power plug. Two electric outlets are provided on the chassis rear for powering BOD respirometers or other equipment inside the refrigerator. No other wiring is required when used with a standard, domestic, 3-pin, 115 V receptacle.

A constant incubation environment is maintained anywhere within the range of 5° to 45°C by temperature-sensitive control circuits which appropriately energize the regulator heater or the refrigerator. The regulator fan operates continuously to insure an even temperature throughout the compartment.

PRICE Model 2597 IncuTrol®/2 Regulator, complete
115 V, 60 Hz or 220 V, 50 Hz $165.00



All prices FOB Ames, Iowa and subject to change without notice

HACH

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LAB-AIDS® #20 POLLUTANT EFFECTS OF PHOSPHATES AND NITRATES KIT

Student Worksheet and Guide

Algae, which are normally present in fresh water will undergo a series of changes when phosphate and nitrate compounds are added. These changes can influence the quality of the entire body of water.

This lab activity allows you to set up and conduct controlled experiments in order to observe and determine what changes occur in pond water as a result of the addition of nitrate and phosphate.

You will be assigned to a group of six (6) students and your group will conduct the activity with a sample of fresh water from any nearby waterway or with a sample provided by your instructor.

PROCEDURE:

The following is the procedure each group of six (6) students should follow:

1. The group obtains 7 clear testing containers. Each student is responsible for one testing container.
2. Label the containers with the pressure sensitive labels (one label/container) numbers 1–7. (#1 will be the control.)
3. Place 90 ml of fresh water from any nearby waterway into each testing container (recording the date and location of the collection on the data sheet).
4. Add the nitrate and phosphate "pollutants" to the containers carefully (counting the drops) each day for a period of 10 days according to the schedule to the right.
5. Place a piece of paper towelling on each container and place the containers in a well lighted area.
6. Even though you have set up only one of the containers, you are responsible for recording in the data chart observations of all 7 containers of your group.

Container	Solutions Added Daily
#1	Nothing added – CONTROL
#2	9 drops phosphate solution
#3	18 drops phosphate solution
#4	9 drops nitrate solution
#5	18 drops nitrate solution
#6	9 drops phosphate and nitrate solution
#7	18 drops phosphate and nitrate solution

WATER SAMPLE:

Date collected _____ Location collected _____

General appearance of sample: _____

_____

Note in the data chart the appearance of the samples and any changes that may occur in the sample and the control in the appropriate spaces. (Comments may range from "no change" to "cloudier appearance," "green color," or for that matter, any subjective interpretation.)

OBSERVATIONS AND INTERPRETATIONS:

1. How many days did it take to observe changes in the algae content of the control (#1)? _____

   in sample #2? _____; #3? _____; #4? _____; #5? _____; #6? _____; #7? _____.

2. How would you describe the algae content of container #2 as compared to #1 (control) after 10 days? _____

   _____

   Container #4 as compared to #1 after 10 days? _____

   _____

   Container #6 as compared to #1 after 10 days? _____

   _____

   Container #6 as compared to #2 and #4 after 10 days? _____

   _____

3. Was the algae content of:

   Container #2 similar or different from the algae content of container #3 after only five days? _____

   Container #4 similar or different from the algae content of container #5 after only five days? _____

   Container #6 similar or different from the algae content of container #7 after only five days? _____

4. What factors may have contributed to your observations? _____

   _____

   _____

   _____

Name _____ Date _____

LAB-AIDS® INC., 1977©

DAY	CONTROL #1	#2	#3	#4	#5	#6	#7
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

DATA CHART

LAB-AIDS® # 19 A QUALITATIVE INTRODUCTION TO WATER POLLUTION KIT

Student Worksheet and Guide

This kit provides the necessary materials and methods for detecting various common water pollutants.

1. Read the instructions carefully before starting any experiment. Measure the chemicals carefully.
2. It is essential that all materials used be clean in order to obtain accurate results.
3. Replace caps and covers of vials and bottles immediately after use to prevent contamination.
4. Where possible, water samples should be drawn closely as possible to the source of supply. Avoid turbulence or air bubbles when filling sample bottles.
5. Carefully record procedures and observations for each sample tested.

I Ammonia nitrogen

Procedure:

1. Measure a 10 ml water sample into the calibrated tube.
2. Add 1 drop of Ammonia Test Sol. # 1 to the water sample. Mix.
3. Add 8 drops of Ammonia Test Sol. # 2 to the water sample. Mix.
4. If ammonia nitrogen is present in sample, a yellow color will develop. Allow 8—10 minutes for full color development.

   (Note: The sample can be poured into the large well of the Chemplate™ to await the time.)

II pH

Procedure:

1. Place a small sample of the water to be tested (8—10 drops) in a cavity of the Chemplate™.
2. Add 1 drop of Universal pH Indicator and mix with the plastic spatula. Compare the color that immediately appears with the list below:

pH 1	cherry red	pH 6	yellow
pH 2	rose	pH 7	yellow-green
pH 3	red-orange	pH 8	green
pH 4	orange-red	pH 9	blue-green
pH 5	orange	pH 10	blue

III Chlorine

Procedure:

1. Fill a Chemplate™ cavity approximately 2/3 full with the water to be tested.
2. Add 2 drops of Chlorine Test Solution and mix with the plastic spatula.
3. If chlorine is present, a yellow color will develop. Allow 5 minutes for full color development.

IV Chromium (chromate)

Procedure:

1. Measure a 10 ml water sample in a calibrated tube.
2. Add a level spatula of the Chromate Indicator Powder. Replace the cap and mix the sample until the powder is dissolved.
3. A reddish-purple color forms in the presence of chromate and the amount of color is directly proportional to the amount of chromium (chromate) present in the sample.

V Copper

Procedure:

1. Fill a Chemplate™ cavity approximately 2/3 full with a sample of the water.
2. Add 1 drop of Copper Test Sol. # 1. Mix and allow to stand for 1 minute.
3. Add 2—3 drops of Copper Test Sol. # 2. Mix and allow to stand at least 2 minutes but not more than 10 minutes.
4. An orange-colored solution indicates the presence of copper.

VI **Cyanide**

Procedure:

1. Measure a 10 ml water sample into the calibrated tube.
2. Add 2 drops of Cyanide Test Sol. # 1 and mix.
3. Add 2 drops of Cyanide Test Sol. # 2 and mix.
4. If cyanide is present, a pink color will develop which turns violet in a few minutes. Allow approximately 10 minutes for the color to develop.

VII **Iron**

Procedure:

1. Measure a 5 ml water sample in the calibrated tube.
2. Add 5 drops of Iron Test Sol. # 1. (This is 5% sulfuric acid – be careful.)
3. Add 1 level spatula of Iron Indicator Powder to the sample. Replace the cap and mix to dissolve.
4. If iron is present, a wine red color will develop. Allow 2 minutes for full color development.

VIII **Nitrate nitrogen**

Procedure:

1. Place approximately 3 ml of a water sample in the calibrated tube.
2. Add enough Nitrate Test Sol. # 1 (2 ml) to bring the sample up to 5 ml. Mix.
3. With the plastic spatula, add 2 level measures of Nitrate Indicator # 2 Powder.
4. Replace the cover and shake until the powder is completely dissolved.
5. If nitrate nitrogen is present, a very light pink color will develop (trace amounts). A reddish purple color will develop with high concentrations of nitrate nitrogen. Allow 5 minutes for full color development.

IX **Phosphorous** (phosphates)

Procedure:

1. Measure a 5 ml water sample in the graduated tube.
2. Add 15 drops of Phosphate Test Sol. # 1 and mix. Allow to stand 3–5 minutes. A light yellow color may appear.
3. Add 2–3 drops of Phosphate Test Sol. # 2. Replace the cover and mix.
4. If phosphate is present, a blue color will form immediately.

X **Silica**

Procedure:

1. Measure a 5 ml water sample in the calibrated tube.
2. Add 3 drops of Silica Test Sol. # 1 and mix.
3. Add 6 drops of Silica Test Sol. # 2 and mix.
4. Add 4 drops of Silica Test Sol. # 3 and mix.
5. Add 1 drop of Silica Test Sol. # 4 and mix.
6. If silica is present, a blue color will form immediately.

XI **Sulfide**

Procedure:

1. Measure a 5 ml water sample in the graduated tube.
2. Add 15 drops of Sulfide Test Sol. # 1 and mix. (Note: This solution has a high sulfuric acid content and care should be taken.)
3. Add 3 drops of Sulfide Test Sol. # 2. Mix and allow to stand for 1 minute.
4. Add 20 drops of Sulfide Test Sol. # 3 and mix.
5. If sulfide is present, a blue color will appear.

Student's Name _____ **Date** _____

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Acid Rain

Name _____

Date of Collection _____

Location of Test Sample _____

_____

City _____

1. Clean one baby food jar and cap.

2. Collect a sample of rain water at your home. Make sure the collecting jar does not receive water from a roof or tree.

3. pH Reading _____ (Testing will be done at school.)

SAMPLE NUMBER	1	2	3	4	5
PLOTTING CODE	x	o	□	•	–
SAMPLE SOURCE					
SAMPLE VOLUME					
SAMPLE DILUTION					

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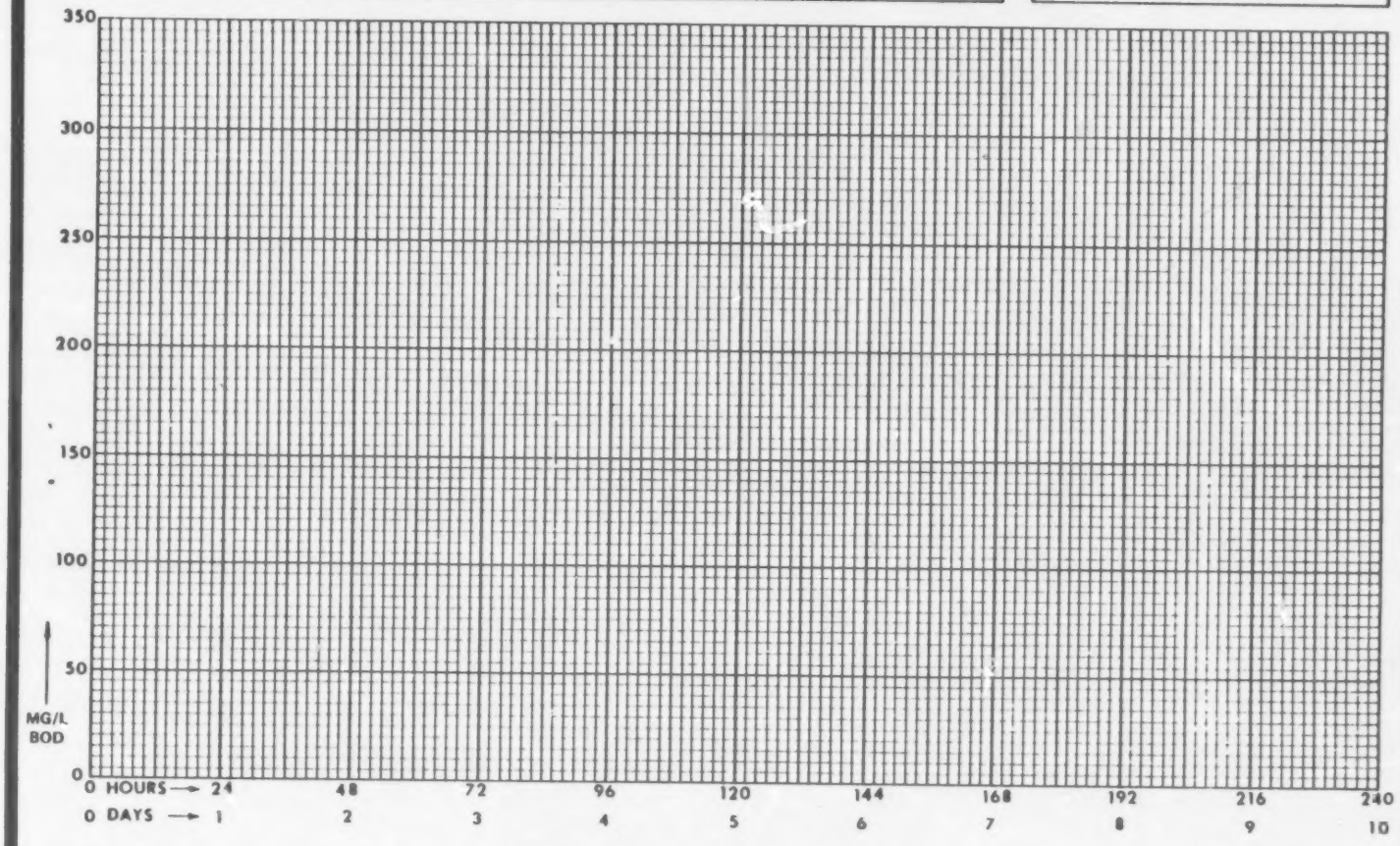
DATE _____
TIME _____
ANALYST _____



BOD DATA CHART

HACH CHEMICAL COMPANY HACH EUROPE S.A./N.V.

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Conservation - Ecology

Name
Hour
Date of testing _____
Water tested – Lake
River
Creek
others

Location _____
_____
_____

Suspended solids

The purpose of this experiment is to measure the concentration in parts per million (ppm) the total solids in water samples.

Equipment needed:

Alcohol burner
150 ml beaker
Burner stand
Graduated cylinder
Watch Glass
Scale

Use a 50 ml sample.

2. Weight of beaker after heating. _____
1. Weight of clean empty beaker. _____

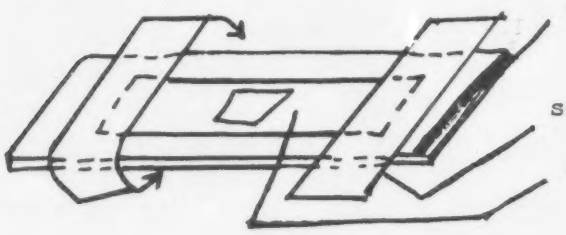
Results _____ g/50 ml

Multiply the results by 20,000

Suspended solids in parts/million _____

Particulate Count Of Air Name _____

1. A clear glass slide and scotch tape is needed.
2. Place the scotch tape on the slide with the sticky side up.
3. Draw a square exactly 1 cm on each side. Use a pencil.
4. Expose the slide for 24 hours wherever the count is to be made.
5. Count all particles within the square. Use the binocular microscope. Fill out data sheet below.



- - - - - - - - - - - - - - - - - - - -

1. School _____
2. City _____ State _____ Zip _____
3. Teacher _____
4. Date Of Sample _____
5. Meteorological Conditions
   Windy ____ Cloudy ____ Sunny ____ Calm ____ Rainy ____
6. Mean Daily Temperature _____
7. Relative Humidity _____% Barometric Pressure _____"Hg
8. Number of Slides Exposed _____ Duration of sample _____ hrs.
9. Average Number of Particles / sq. cm. _____
10. Average Particle Size _____ microns (if microscope available)
11. Comments _____

_____

_____

U N I T I I I

E C O L O G I C A L C O N C E P T S

OBJECTIVES

OBJECTIVE - UNIT III - The student will recognize and integrate the interrelationships of basic ecological concepts which exist between all organisms and their environment.

I. The student will understand the basic principles underlying the process of photosynthesis and the importance of its product to the existance of all organisms.

CONTENT OUTLINE

I. Photosynthesis In General

A. It is the process by which light energy is converted to chemical energy.

1. Uses light energy, the most abundant energy available.

2. Photosynthesis locks the energy of the sun into the bonds of glucose molecule.

3. It is from this molecule that energy and basic molecules of living systems are derived.

II. The energy on which all life depends enters our biosphere in the form of light.

A. There are 14 types of radiations together called the electromagnetic spectrum.

B. The visible spectrum

1. The visible spectrum colors are related to wave length.

2. Absorption spectrum of chloroplasts is limited to the red-orange area and the blue area.

C. The pigments involved in photosynthesis

1. Structure of the chlorophyll molecule

a. it has a magnesium center
b. it has 4 nitrogen atoms around the magnesium
c. there is a long hydrocarbon side chain
d. type a and 6 chlorophyll exists

2. The chloroplasts

a. flattened structures about 7 u m to 3 - 4 u m in width
b. they have an outer and inner membrane very close together

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Questions from "Molecules To Man"		Questions will be turned in.
III. General discussion with emphasis on why the photosynthetic product (glucose) is the basic molecule needed by all living systems.		
I. Lecture - note taking by students	Overhead projector and transparencies	
II. An exercise to separate white light	Hand held spectroscope Light source	
III. Quiz		Quiz - Electromagnetic Spectrum
IV. Laboratory exercise to observe living chloroplasts	Microscopes Elodea plants Slide Slide covers	A detailed sketch of Elodea plant cells and chloroplasts will be turned in.

OBJECTIVES	CONTENT OUTLINE
	c. stroma 1. fluid matrix 2. dark reaction takes place here d. grana 1. light reaction takes place here D. The leaf 1. Functions as a photosynthetic factory a. upper epidermis b. palisade layer c. spongy layer d. lower epidermis e. stomata (guard cells) f. vein E. Raw materials needed by photosynthesis 1. Water (H_2O) is needed to provide the H for the glucose sugar molecule 2. Carbon dioxide (CO_2) is needed to provide C for the glucose sugar molecule 3. Oxygen from the water (H_2O) is released to the atmosphere F. Finally photosynthesis with CO_2 from the atmosphere, H_2O from the ground, and light energy from the sun produces $C_6H_{12}O_6$ simple sugar upon which all organisms depend. * See photosynthesis diagram at the end of this unit.
80	81

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
V. Laboratory exercise to observe a cross-section of a leaf.	Microscope Prepared microscope slides	A labeled sketch of the cross section will be turned in.
VI. Conclusion:		
A. Review all materials on photosynthesis discussion, question and answer sessions.		
B. Questions from "Molecules To Man" to be answered	Biological Sciences Curriculum Study "Molecules To Man"	Answered questions will be turned in along with review sheet and vocabulary list.
C. Questions from review sheet to be answered.		
1. Vocabulary sheet to be included.	Vocabulary sheet	A test will be given that will cover all material presented on photosynthesis.
D. The teacher will provide individual help when needed.		

OBJECTIVES	CONTENT OUTLINE
II. The student will be able to enumerate details in describing the elemental cycles.	I. The Elemental Cycles A. Comparison of the size of the earth with a sphere composed of all living substance (protoplasm) that has ever existed. 1. A sphere of all protoplasm that has ever existed would be much larger than the present earth sphere. a. the only possible explanation of this fact would be that elements of protoplasm are used in a never ending cycle. B. Of the 105 elements known to science about 35 contribute to the formation of protoplasm. 1. Carbon, hydrogen, oxygen, 2nd nitrogen form about 96% of the human body a. elements such as sodium, calcium, potassium, magnesium, sulfur, cobalt, zinc, iron, iodine, and many others occur in smaller amounts 2. All of these element forming living organisms are derived from the surface of the earth. a. from the few inches of top soil b. from rivers c. from lakes d. from oceans e. from the thin atmospheric blanket of air 3. The only way to explain a cumulative ball of protoplasm larger than planet Earth is to assume that the elements of protoplasm are used over and over again. a. the element nitrogen that might have been part of a dinosaur's muscle may be part of a human brain later, and part of a tomato later yet.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Discussion and oral questions and answers concerning elemental cycles.		
III. The students will watch a TV tape "Ecology".	TV tape from AV department	
IV. Quiz		Quiz will be given to cover the general information to this point.

86

87

OBJECTIVES	CONTENT OUTLINE
III. The student will be able to explain the necessity and sequential steps of the nitrogen cycle.	I. The Nitrogen Cycle A. Nitrogen is a colorless, tasteless, odorless gas which forms about three percent (by weight) of living protoplasm. 1. An important component of: a. chlorophyll b. hemoglobin c. insulin d. DNA e. many other proteins B. Nitrogen is extremely abundant 1. It forms about 80 percent of the atmosphere a. there are about 34,000 tons of nitrogen in the air column above each acre of the earth's surface C. Securing nitrogen is very difficult for living organisms 1. It is chemically inactive since it forms a triple bond with itself in atmospheric form. 2. Organisms cannot use oxygen in this elemental form. 3. The 11,000 quarts of nitrogen you breath into your lungs each day are exhaled back into the atmosphere. D. How can man and living organisms make use of nitrogen in the synthesis of life proteins? 1. Nitrogen must be "fixed" converted to a form which is usable. 2. Fixing means combining nitrogen with hydrogen to form ammonia (NH_3). a. small amounts are fixed during electrical storms
88	89

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Discussion on why nitrogen is important to living systems.	Projected Learning Program, Inc. "Proteins" #90-954 Projector	
III. Emphasize the triple bond to show why nitrogen is not readily available to living systems.		
IV. Question found at the end of this unit will be answered A. Individual help will be given when needed.	Question sheet for each student	Answers to questions will be handed in.

90

91

OBJECTIVES	CONTENT OUTLINE
	b. a small amount is fixed by volcanic eruptions c. the most important is fixation by micro-organisms such as bacteria and blue-green algae E. The cycle 1. See the end of this unit for sequential steps and diagram.
IV. The student will be able to explain the necessity and the sequential steps of the carbon cycle.	I. The Carbon Cycle A. Carbon is the key element in the molecular structure of all living organisms, from bacteria to man. 1. The atmosphere provides the principle carbon reservoir. 2. Six tons of carbon occur in the air column above each acre of the earth's surface. a. one acre of vegetation will remove 20 tons of carbon from the atmosphere each year. b. it is combined with hydrogen to form sugar during the process of photosynthesis. c. later the plants are consumed by plant eaters, such as deer, and carbon-containing compounds are digested and converted to animal protein. d. some carbon is released by both plants and animals in the form of respiration e. living organisms (clover, deer, man, etc.) eventually die, in addition animal wastes are broken down by bacteria and fungi which release carbon to the air.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students II. Discussion on why carbon is important to living systems A. Show how the carbon atom forms the central core of all biological molocules	Overhead projector and transparencies Projected Learning Programs, Inc. "Carbohydrates" #90-952 Projector	

94

95

OBJECTIVES	CONTENT OUTLINE
	II. The Carboniferous Period A. About 300 million years ago, giant ferns and other plants grew in what is now known as Pennsylvania, West Virginia, Ohio, Kentucky, Tennessee, Indiana, and Illinois. 1. As these plants died, they were covered with sediment resulting in the formation of coal. 2. Crude oil and natural gas formed in a similar fashion. B. These carbon "fossil fuels" were removed from circulation for 300 million years. C. The oceans also serve as a reservoir for carbon. 1. The carbon is in the form of carbon dioxide dissolved in water. 2. It may enter the ocean from the overlying atmosphere. 3. The carbon dioxide: a. may be incorporated into the plant body by photosynthesis b. eventually the carbon is incorporated into the bodies of plant-consuming fish and fish eating animals, such as sharks, tuna, waterfowl, whales, and man. c. some carbon dioxide is returned to the ocean by respiration of marine organisms. 4. Some carbon is used for: a. building limestone shells and "skeletons" by clams, oysters, scallops, and corals. b. tremendous quantities of carbon are "locked up" in coral reefs off the coasts of Florida and California. c. the Great Barrier Reef off the Australian coast is a mass of limestone 180 feet thick and 1,260 miles long.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students II. Discussion with emphasis on remains of living systems in the form of crude oil, natural gas, and coal.	Overhead projector and transparencies	

98

99

OBJECTIVES	CONTENT OUTLINE
	D. For millions of years the carbon cycle was in dynamic equallibrium. 1. Man has now released 200 billion tons of carbon dioxide into the atmosphere causing a 10 percent increase. a. from 290 ppm to 320 ppm 2. By the year 2000 atmospheric carbon will have increased another 25 percent to 400 ppm. 3. Scientists do not know what effect this will have on human survival. a. climate changes due to carbon dioxide acting as a "heat trap" might occur
V. The student will understand the various interrelationships within a food chain and list the succession of steps involved.	I. Food Chains A. A food chain may be defined as the transfer of energy and nutrients through a succession of organisms by the processes of eating or being eaten. 1. A representative food chain of a wet meadow could be: grass → grasshopper → frog → snake → hawk 2. The initial link (grass) is classified as a producer. a. it produces chemical energy in the form of sugar by the process of photosynthesis. b. this sugar (glucose) energy must be passed on c. this energy either directly or indirectly powers the activities of all organisms on earth.
100	101

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
III. Discussion with emphasis on the effects on climate by addition of great quantities of carbon dioxide to the air.		
IV. Review all of material dealing with the nitrogen and carbon cycle.		
A. Question found at the end of this unit will be answered	Question sheets for each student	Answers to questions will be handed in.
1. Individual help will be given when needed.		
V. Quiz		The quiz will cover briefly the carbon and nitrogen cycles.
I. Lecture - students take notes	Overhead projector and transparencies	
II. Discussion with emphasis on what constitutes a food chain and a food web.		
III. Discussion of simplified ecosystems such as Ireland's potato economy of 1800 and our present corn, wheat ecosystems.		

OBJECTIVES	CONTENT OUTLINE
	3. The grasshopper is considered an herbivore, a plant eater. (so is a cow, elephant, buffalo) 4. The frog is considered an insectivore, an insect eater. 5. The flesh eating links of the snake and hawk are considered to be carnivores. 6. Energy is lost at each step of the chain. II. Food Webs A. A food web may be defined as an interconnected series of food chains. 1. Within the food chain corn-pig-man, the pig eats other foods such as rats, mice, insects, grubs, earthworms, baby chicks, grass, weeds, and garbage. 2. Man also consumes other things besides pork, in fact everything from artichokes to zwieback, everything that swims, flys, crawls, or runs. B. In nature food chains exist as separate strands of an interwoven food web. C. As a general rule of stability and survival, the greater the number of alternative channels through which energy can flow the greater will be the stability of the food sources enhancing survival. *See diagram of the California chaparral at the end of this unit. D. Man has sometimes created problems for himself in his attempt to simplify ecosystems, promoting instability. 1. Example: Ireland's potato oriented agriculture of 1780 to 1845 created a disaster between the years 1845 to 1850.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION

106

107

OBJECTIVES	CONTENT OUTLINE
VI. The student will recognize the energy levels as they relate to organism number at each step within an ecological pyramid.	I. Pyramid Of Numbers A. In a predator food chain the numbers of individuals are greatest at the producer level, less at the herbivore level, and smallest at the carnivore level. *See diagram of pyramid of numbers at the end of this unit. II. The Laws Of Thermodynamics A. The first law states that energy cannot be created or destroyed, however it can be converted from one form to another. 1. A coal powered electric power plant is an example: coal--fire--water--steam--steam turbine--electric generator--electricity B. The second law states that whenever one form of energy is converted to another a certain amount will be lost as heat. 1. Only 25% of gasoline energy is converted to mechanical energy of motion. a. seventy-five percent is lost as heat III. Pyramid Of Energy A. All organisms require energy for their life processes. 1. Unlike elements, energy cannot be cycled, but is continuously being lost from the ecosystem. 2. Energy must be continuously replenished by the sun. B. Every twenty minutes the sun rays striking the U.S.A. constitutes enough energy to meet the country's entire power needs for a year.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes	Overhead projector and transparencies	
II. Discussion relating the pyramid of numbers with the pyramid of energy.		
III. Review worksheet to be done. It will include the nitrogen carbon cycles, pyramid of numbers, and the pyramid of energy.	Worksheet	Worksheet to be handed in when completed.
A. The teacher will provide individual help when needed.		
IV. Sound filmstrip, "Solar Energy" to be shown	Sound filmstrip, "Solar Energy" Thomas J. McMahon Educational Materials and Equipment Company Projector	

OBJECTIVES	CONTENT OUTLINE
	C. A very small percentage of this solar energy is put to use. 1. Plants, through photosynthesis, can convert only one percent of the sunlight striking them into chemical energy of sugar molecules. 2. A cow can convert only ten percent of the total alfalfa or grass mass into beef. 3. Flesh-eating man is only about ten percent efficient in converting beef into human flesh. D. Of the original 1000 calories of energy shining on green plants only .1 calorie will be available to man. *See diagram of energy pyramid at the end of this unit. E. American and Asian diets 1. An American reaching the age of 70 will have consumed: a. 10,000 pounds of meat b. 28,000 pounds of milk and cream c. thousands of pounds of grain, sugar, and specialty foods 2. An Asian diet is much more efficient. a. an Asian reaching 70 years of age will have consumed 100 pounds of meat b. an Asian diet consists of only two links in which man replaces the cow, sheep, or pig in eating grain and plants directly.
112	113

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION

114

115

OBJECTIVES	CONTENT OUTLINE
VII. The student will be able to describe how population growth of a species will form a graphed sigmoid curve when introduced into a new habitat of good carrying capacity.	I. Population Growth Curves A. The population number of any specie will be the result of the interaction of two antagonistic forces, environmental resistance (ER) and biotic potential (BP). 1. The BP will tend to push the population upward. 2. The ER will tend to push the population downward. B. When BP is greater than the ER, the population rises. C. Conversly when the ER is greater than the BP, the population declines. D. When the BP and ER values are the same, then the population gains stability. II. A sigmoid (S-shaped) growth curve is characteristic when a species is introduced into a new habitat with good carrying capacity. A. Such a curve consists of four phases: 1. The establishment phase 2. The explosive (logrithmic) phase 3. The deceleration phase 4. The dynamic equalibrium phase B. Examples of exotics introduced into the United States from abroad: 1. A few pairs of English sparrows were introduced in 1899, ten years later the sparrow population was in the thousands. 2. The European starling, the German carp have followed the same growth curve as the English sparrow.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes	Overhead projector and transparencies	
II. Discussion dealing with the interpretation of a graphed sigmoid curve.	Give students handout of population curve graph located at the end of this unit.	

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OBJECTIVES	CONTENT OUTLINE
	C. Many exotics have destroyed wild life habitats, spread disease, or have aggressively competed with more valuable species for food, cover, and breeding sites. D. A given crop of bluegills, deer, pine, or pheasants can periodically be harvested without harming the overall population. 1. How to secure the maximum sustained yield (optimum yield) from a given resource is a problem. 2. Productivity is highest at a point between the BP and ER approximately at fifty percent of the carrying capacity of the habitat.
VIII. The student will be able to describe biological succession of both plant and animal environments.	I. Biological succession is the replacement of one community of organisms with another in an orderly predictable manner. A. Primary succession develops in an area not previously occupied by a community. 1. The pioneer community stage is adapted to withstand extremes in temperature and moisture. a. jagged outcropings, a lava-covered slope, rubble from a landslide, slag heaps from an open pit-mine, etc. 2. A crustose lichen can become established making way for other plants. a. lichens modify the environment beginning with weak carbonic acid (H_2CO_3) to corrode the underlying rock.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes	Overhead projector and transparencies	
II. Discussion for clarity of succession as it occurs in the plant and animal communities.		
III. Give students handout of aquatic and plant succession.	Handout of both aquatic and plant succession are located at the end of this unit.	
IV. Conclusion:		
A. A review to include:		
1. Nitrogen and carbon cycles		
2. Ecological pyramids		
3. Food chains and food webs		
4. Population growth		
5. Biological succession		
B. Worksheets are to be completed.	Worksheets	Worksheets are to be handed in.
1. These worksheets should include subjects mentioned in (A).		

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OBJECTIVES	CONTENT OUTLINE
	b. windborn sand, dust, and organic debris begin to accumulate c. lichen die, bacteria and small fungi cause its decay d. slowly the relatively sterile soil is enriched by the invasion of animals like insects 3. Once sufficient soil has accumulated, mosses and ferns arrive. 4. Ferns eventually shade out lichens and replace them in succession. a. the soil becomes further enriched with decay of fern fronds each autumn. 5. As decades pass, windblown pine seeds may fall on the area slowly causing pines to succeed the ferns. 6. As seasons pass, grey squirrels may bury acorns as they wander in from a neighboring oak stand. a. bluejay, raccoons can also transport acorns 7. Young oak seedlings get a good start in the shade of the pines. a. as some pines die they are replaced by an oak b. ultimately an oak forest develops with its complement of plants and animals 8. From the bare, windswept rock outcropings to the oak forest may take several centuries to develop. B. Secondary succession develops in an area previously occupied by another community. 1. Abandoned cotton fields of Georgia are an example. 2. This type of succession passed from grasslands to oak-hickory forest in about 150 years.
124	125

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
2. Vocabulary sheet to be included C. Individual help will be given when needed.		A test will be given to cover all material beginning with the nitrogen cycle to the end of this unit.

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OBJECTIVES	CONTENT OUTLINE
	C. Animal succession occurs along with plant succession. 1. Animal succession would have to depend upon factors such as food, water, protective cover, breeding sites, temperature, and humidity. D. An acquatic succession is shown in a diagram at the end of this unit.

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
	References: Helena Curtis, Biology Oliver S. Owen, Natural Resource Conservation, An Ecological Approach Lawrence W. McCombs, Nicholas Rosa, What's Ecology Bette J. DelGiorno, Millicent E. Tissair, Environmental Science Activities Handbook Lawrence Pringle, One Earth, Many People	131

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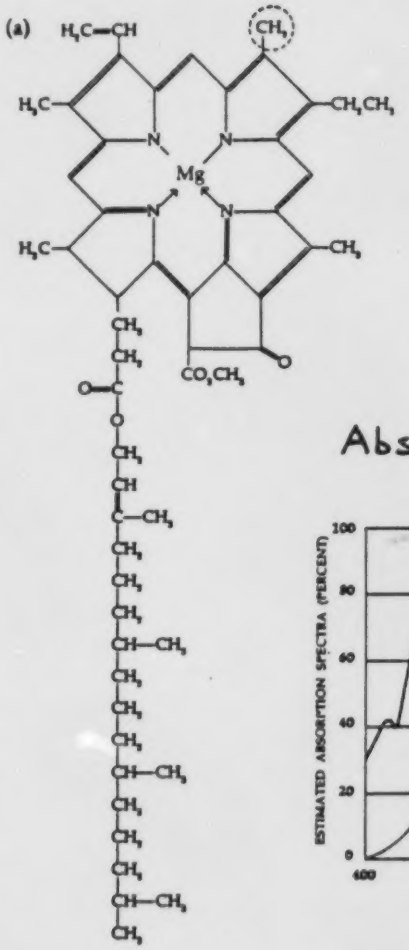
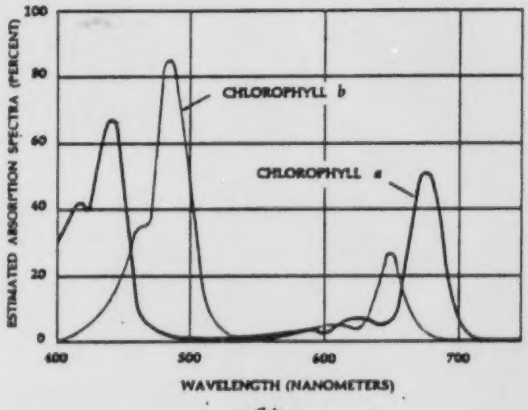
The chlorophyll molecule

(a) *Chlorophyll a is a large molecule with a central core of magnesium held in a porphyrin ring. Attached to the ring is a long, insoluble carbon–hydrogen chain which serves to anchor the molecule in the internal membranes of the chloroplast. Chlorophyll b differs from chlorophyll a in having a CHO group in place of the encircled CH_3 group. Alternating single and double bonds, such as those in the chlorophylls, are common among pigments. (b) The estimated absorption spectra of chlorophyll a and chlorophyll b. (Prepared by Govindjee.)*

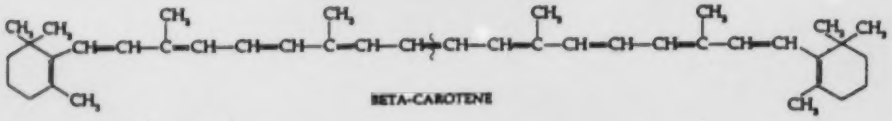


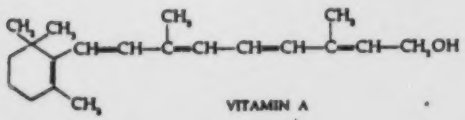
Absorption spectra

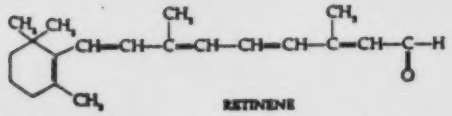


(b)

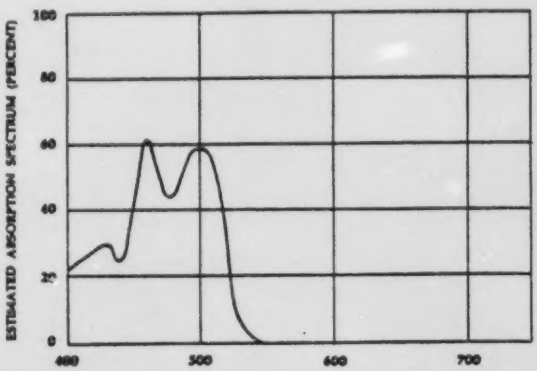
(a) *Related carotenoids. Cleavage of the beta-carotene molecule at the point shown yields two molecules of vitamin A. Oxidation of vitamin A yields retinene, the pigment involved in vision. All of this explains why you were told to eat your carrots. (b) The estimated absorption spectra of carotenoids in the chloroplast. (Prepared by Govindjee.)*


BETA-CAROTENE


VITAMIN A

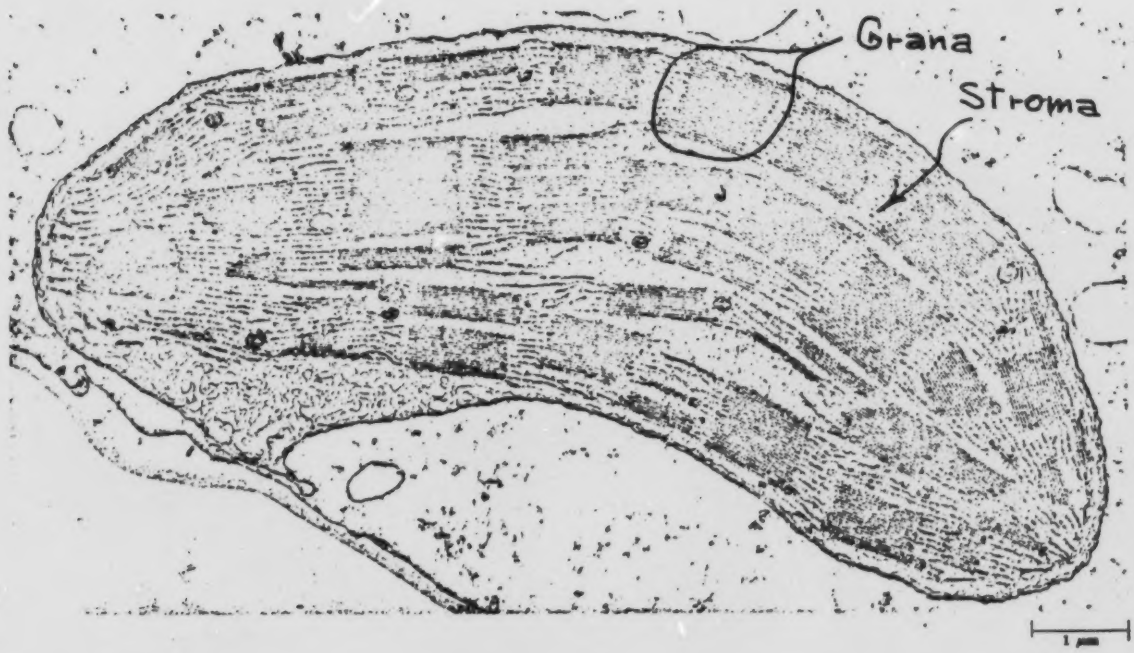

RETINENE

(a)

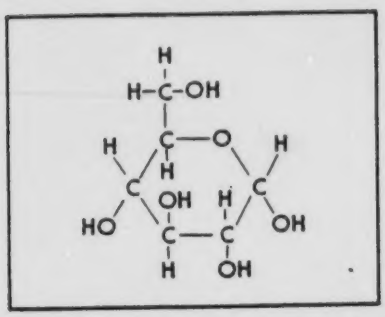


(b)

Chloroplasts

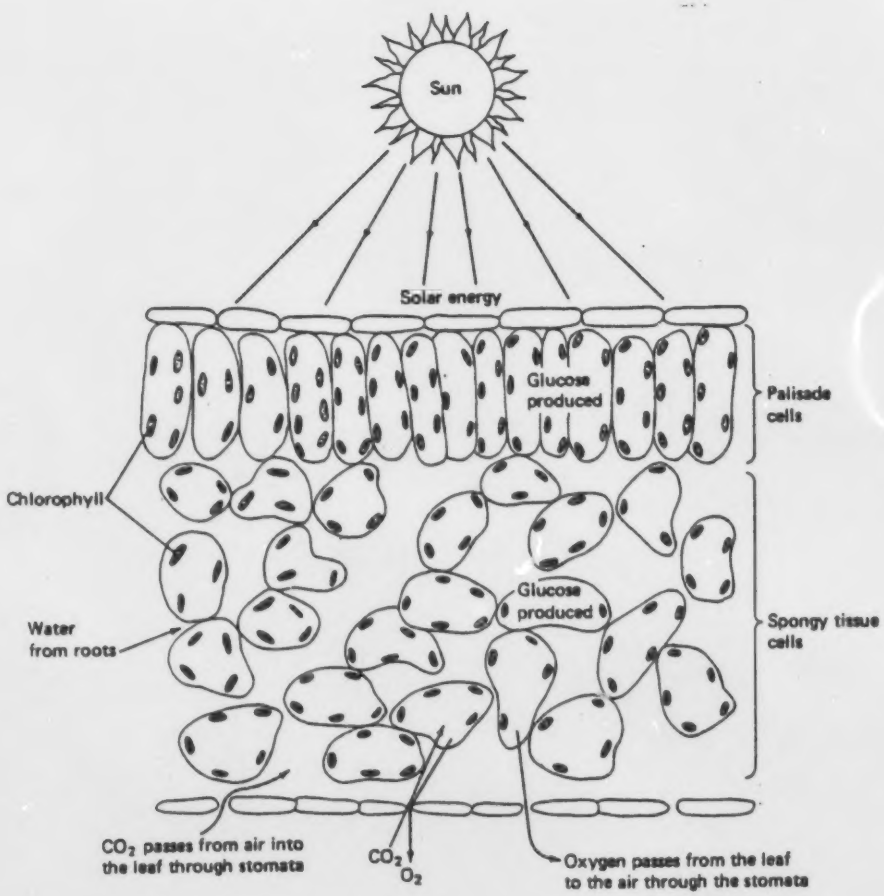


Glucose molecule



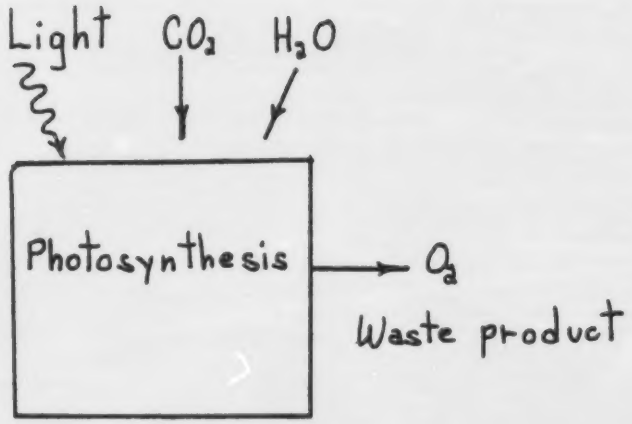
The structural formula for the sugar called glucose, a common and important food source.

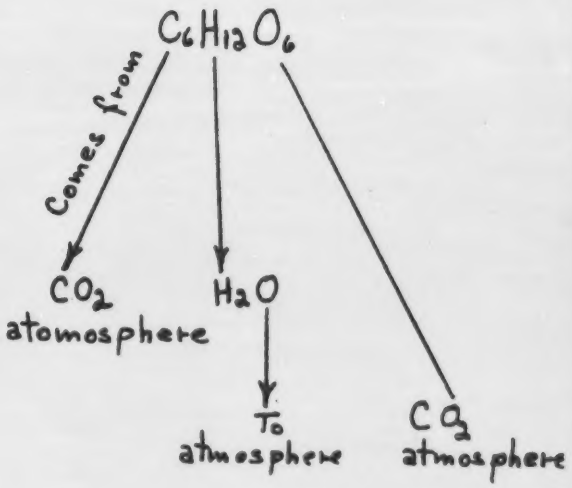
A cross-section of a leaf



A food "factory." A cross-section of a green plant leaf showing some of the aspects of photosynthesis, the food-manufacturing process that occurs in the chloroplasts of the palisade and spongy tissue cells.

Raw materials and product of photosynthesis





Food in the form of:

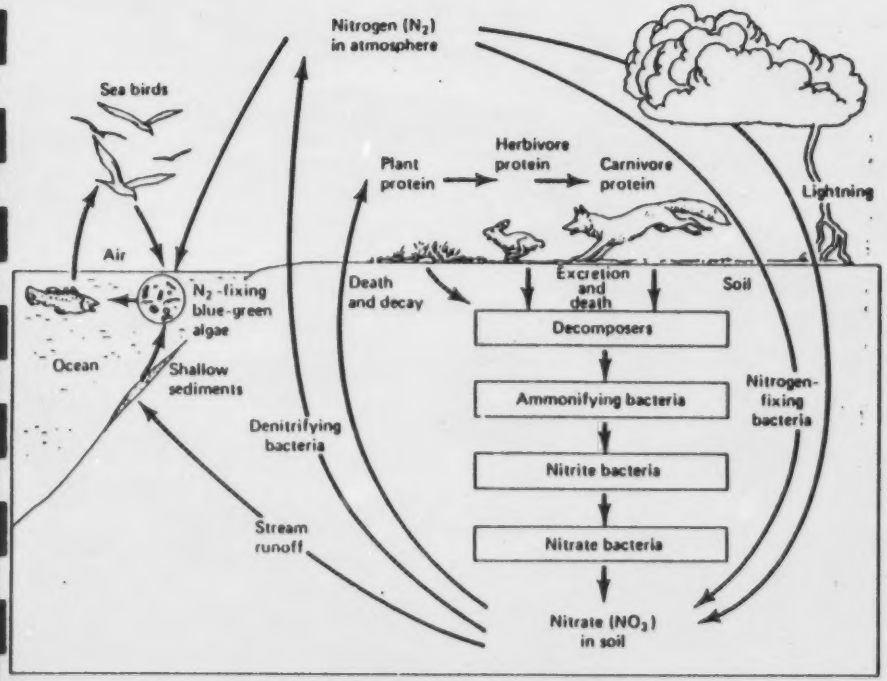
Glucose
Fructose
$C_6H_{12}O_6$

Carbohydrates

Fats

Proteins
- Skin
- Blood
- Muscle
- All cells
- Plant protein

The Nitrogen Cycle



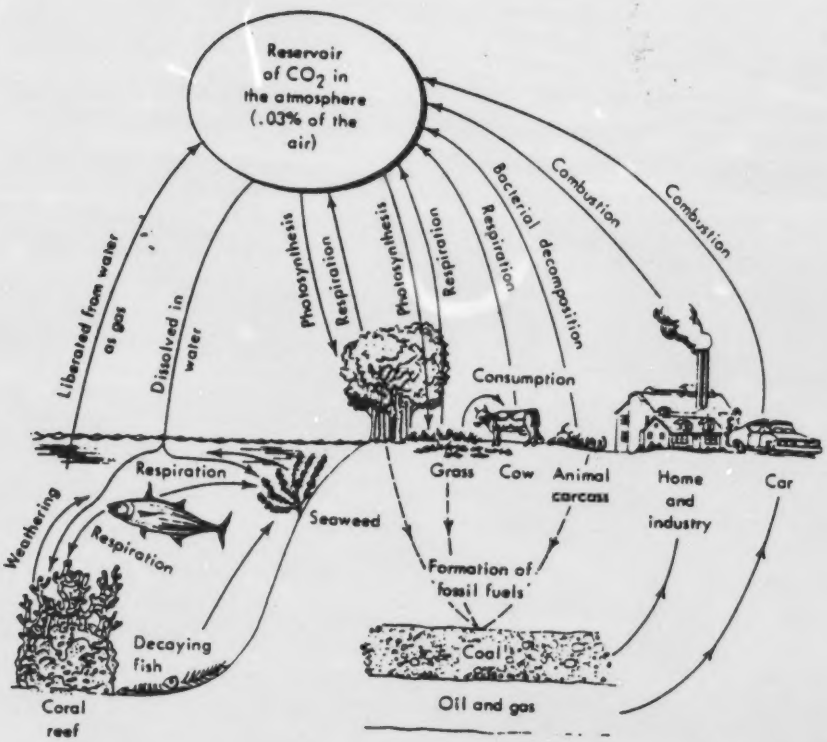
1. Nitrogen diffuses from the atmosphere into the air spaces of soil.
2. It enters the root swellings (nodules) of an alfalfa plant, where the nitrogen-fixing bacteria are located.
3. Here the nitrogen-fixing bacteria combine the nitrogen with hydrogen to form ammonia and eventually incorporate the nitrogen into amino acids, the "building blocks" of proteins.
4. The host alfalfa plant then builds up its own protein from the surplus amino acids not required by the bacteria.
5. After a cow (or other consumer) feeds on the alfalfa, the nitrogen in the alfalfa is eventually incorporated into cow protein.
6. The cow excretes nitrogen-containing wastes (manure and urine). Or the cow may die, and its carcass may lie on the ground.
7. The large, complex, nitrogen-containing protein molecules in the wastes (or carcass) are then broken down (decomposed) by successive groups of bacteria:
   a. the *bacteria of decay* convert the proteins into ammonia (NH_3).
   b. the *nitrite bacteria* convert the ammonia into nitrites (NO_2), such as potassium nitrite (KNO_2).
   c. the *nitrate bacteria* then convert the nitrites into nitrates (NO_3), such as potassium nitrate (KNO_3).

   The above process in which nitrate compounds usable to plants are produced by the action of bacteria on nitrogen-containing organic material is known as *nitrification*.
8. A plant, such as corn, wheat, or oak, may now absorb the soluble nitrate through its roots and use them to build up its own essential protein compounds, such as chlorophyll.

We have suggested that ecosystems are not rigidly isolated from each other but that there exists a limited flow of energy and materials from one to another. Nitrogen also "flows" from one ecosystem to another, for example from a terrestrial ecosystem to an aquatic ecosystem and back to a terrestrial ecosystem again, as shown Fig. 2-5. Thus:

1. The soluble nitrate salts formed by the decay of a rabbit carcass may be washed into a stream and eventually carried to the ocean.
2. The nitrates may be absorbed by marine algae.
3. The algae may be consumed by crustaceans which in turn are eaten by fish which in turn are consumed by cormorants.
4. The cormorants then fly back to their nesting colony on the California coast and feed some of the partially digested fish to their young. Or the adult bird may excrete some waste as it flies over a California farmland, thus to a slight degree contributing to its fertility.

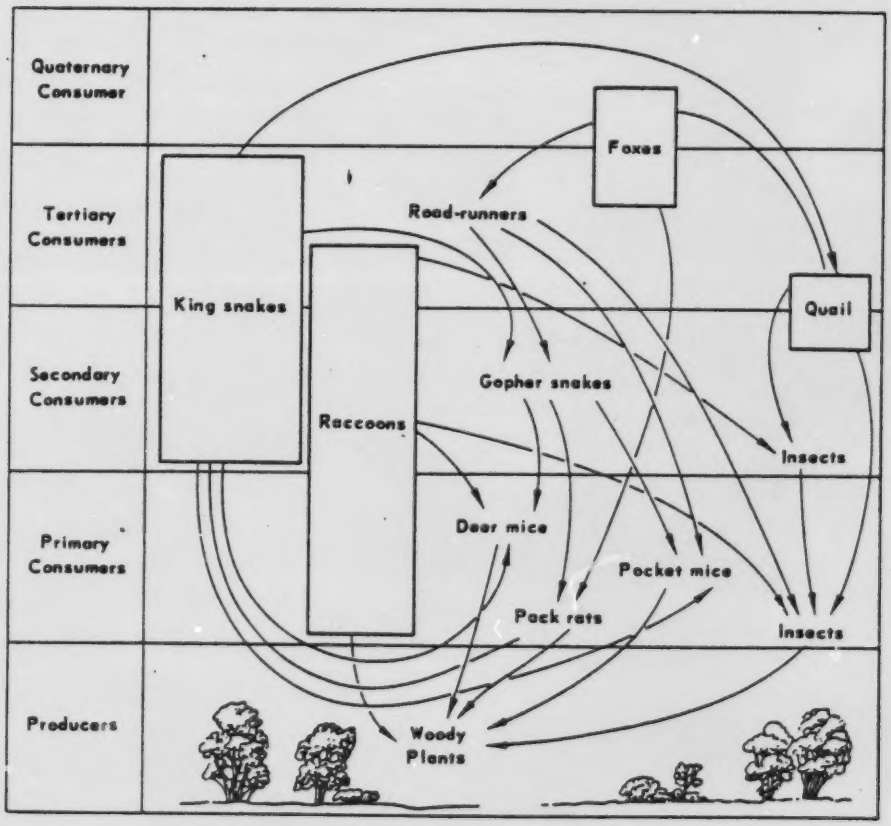
The Carbon Cycle



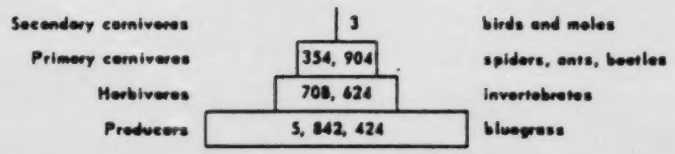
The carbon cycle.

A Food Web

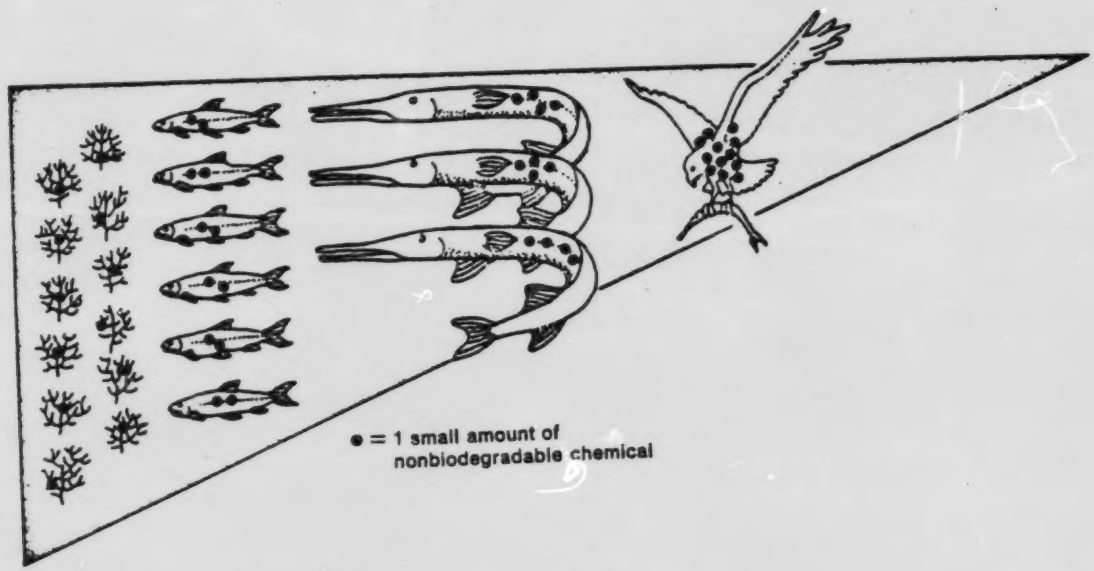
Food web in a California chaparral. All the consumers depend either directly or indirectly on the woody shrub "producers." Foxes, quail, and king snakes all occasionally assume the role of scavenger as well as predator. (Adapted from Arthur S. Boughey, Ecology of Populations *[New York: Macmillan Publishing Co., Inc., 1968].)*



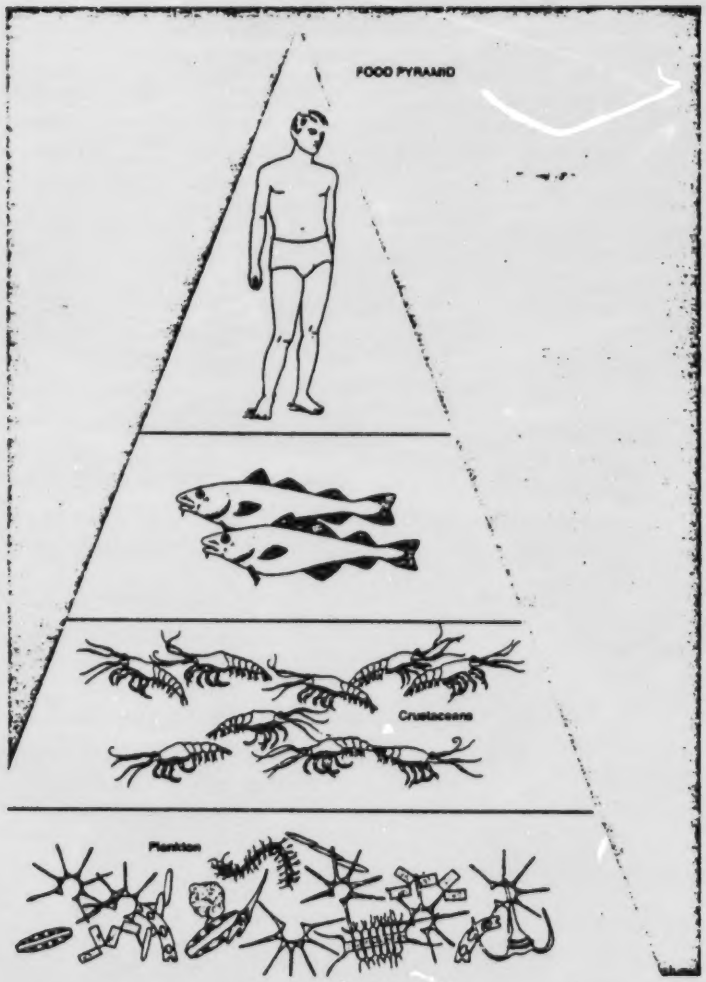
Pyramid of Numbers



Pyramid of numbers occurring in a one-acre plot of blue grass. Organisms are arranged according to trophic (food) levels. (Adapted from Eugene P. Odum, Fundamentals of Ecology *[Philadelphia: W. B. Saunders Company, 1953]. Plant data from Francis C. Evans and Stanley A. Cain, "Preliminary Studies on the Vegetation of an Old Field Community in Southeastern Michigan,"* Contribution of the Laboratory of Vertebrate Biology, University of Michigan, *51 [Ann Arbor: University of Michigan Press, 1952], pp. 1–17. Animal data from G. N. Wolcott, "An Animal Census of Two Pastures and a Meadow in Northern New York," Ecol. Mono., 7 [1937], pp. 1–90.)*

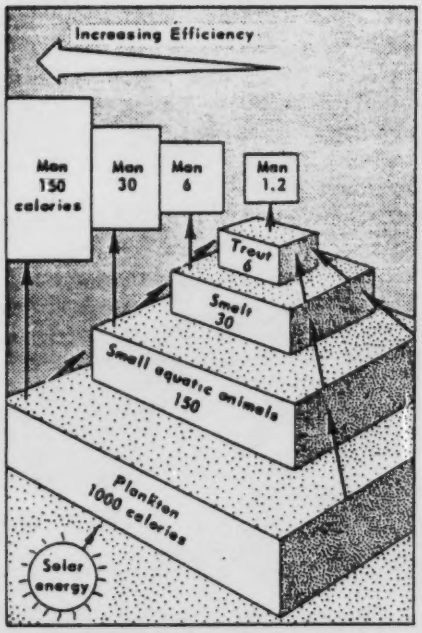


Food pyramid



All life in the oceans depends on the tiny phytoplankton at the bottom of the food pyramid. Humans harvest most seafood from the top of the food pyramid. Much more food energy is available from the bottom layers, if ways can be found to use plankton and shrimplike krill as food.

Energy Pyramid

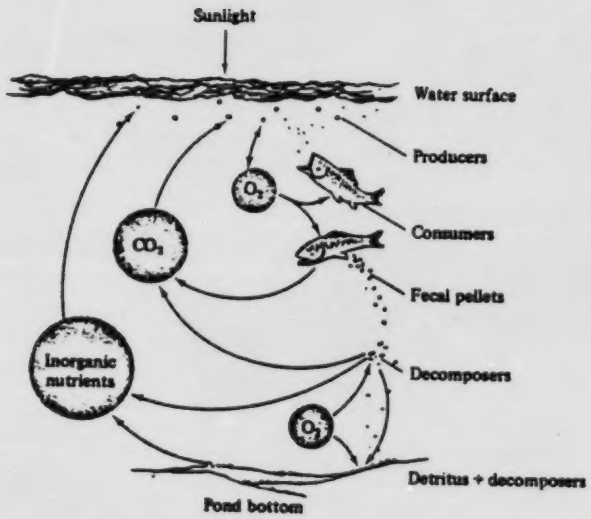


Energy pyramid. If man were the only other link in the plankton-man food chain, more than 100 times the energy would be available to him than as the terminal link of the plankton-aquatic animal-smelt-trout-man food chain. (Adapted from Robert B. Platt and George K. Reid, Bioscience *[New York: Reinhold Publishing Corp., 1967]. After Lamont C. Cole, "The Ecosphere," Sci. Amer., 198 [1958].)*

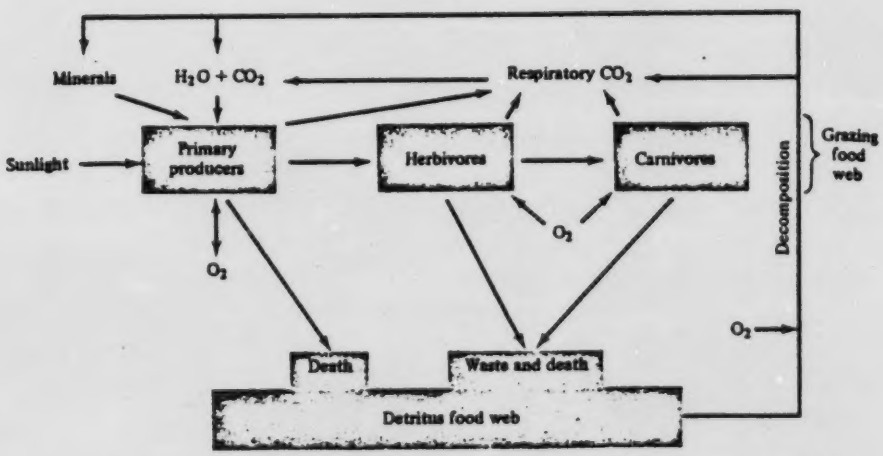
Solar energy (1000 cal)	→	Grass energy (10 cal)	→	Cow energy (1 cal)	→	Human energy (0.1 cal)

Human energy	0.1 cal
Cow energy	1 cal
Grass energy	10 cal
Solar energy	1000 cal

Carbon Dioxide and Inorganic Nutrient Cycle

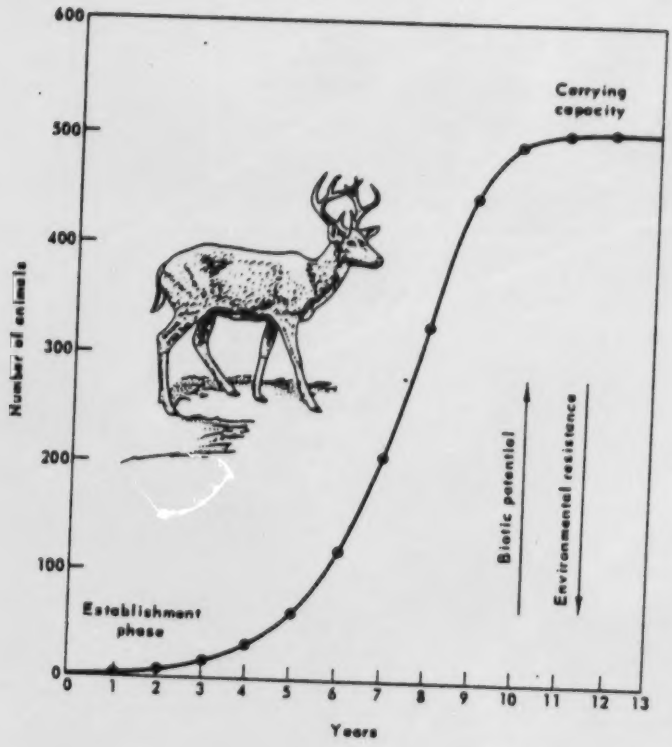


An idealized diagram of materials flow in an aquatic ecosystem. Carbon dioxide and inorganic nutrients are taken up by producers and released by consumers and decomposers. The circulation is driven by sunlight and may be limited by the rate at which nutrients are recycled by consumers and decomposers.



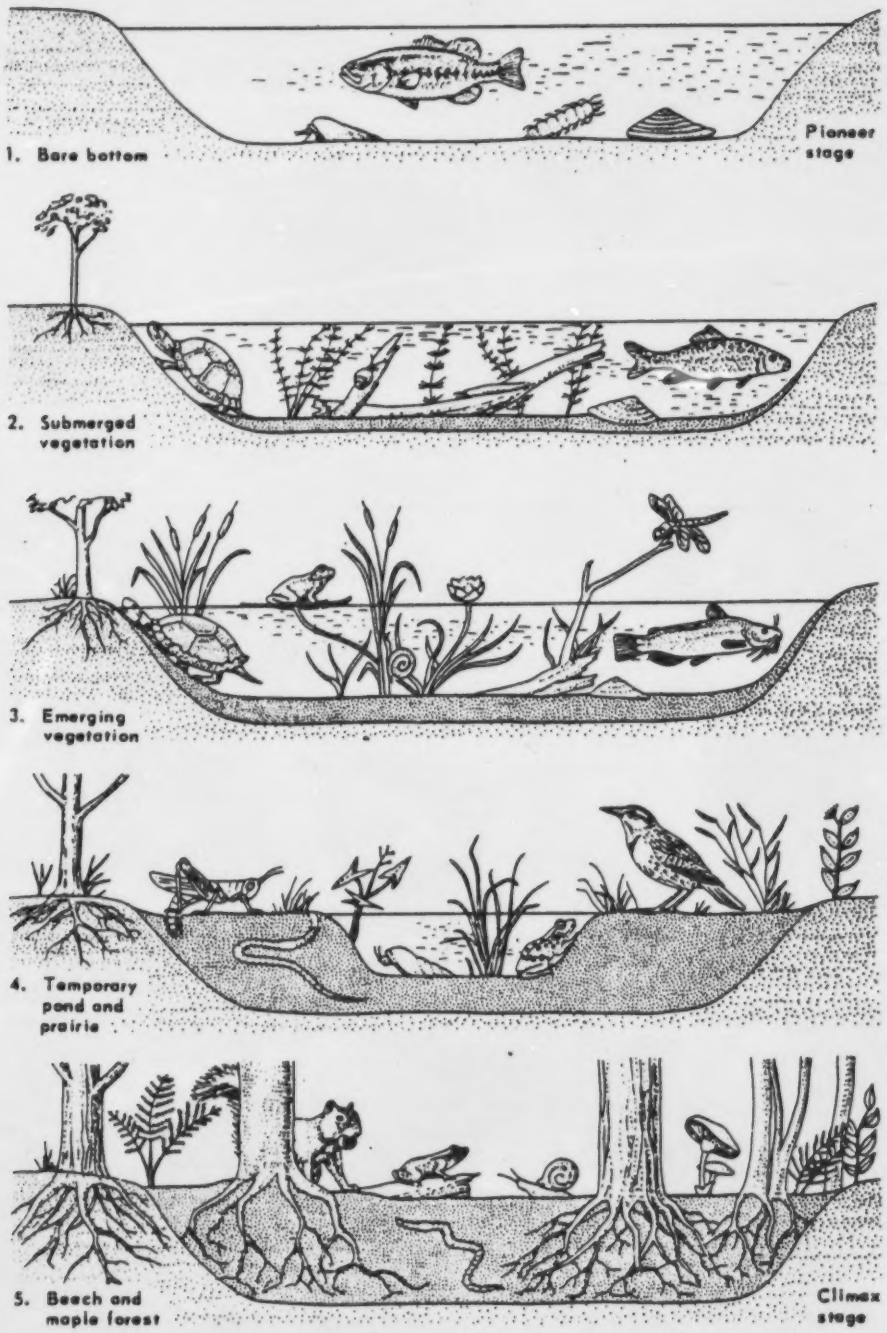
Diagrammatic representation of chemical flow in grazing and detritus food webs.

Population Growth Curve (Sigmoid Curve)



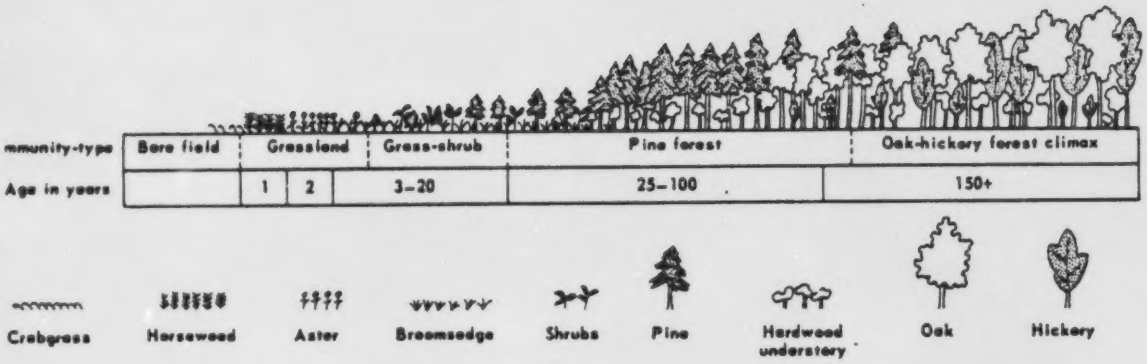
Population growth curve. Note the S-shaped (sigmoid) form. The antagonistic influences of the biotic potential and environmental resistance are indicated by arrows. This curve shows the population increase of deer introduced into a new environment with a 500-animal carrying capacity. (Adapted from. Raymond F. Dasmann, Environmental Conservation *[New York: John Wiley & Sons, Inc., 1959].)*

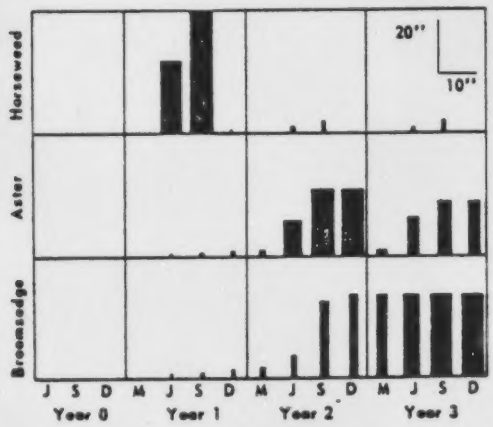
Aquatic succession

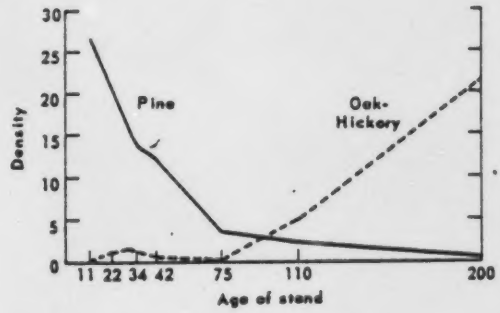


Aquatic succession beginning with bare-bottom pond (pioneer community) and terminating in beech-maple forest (climax). This type of succession is thought to be typical of many ponds in the Midwest. Note the gradual accumulation of humus (shown in stippling black). (Adapted from R. and M. Buchsbaum, Basic Ecology *[Pittsburgh, Penn.: Boxwood Press, 1957].)*

Secondary succession







Secondary succession in an abandoned field in the Piedmont region of southeastern United States. Note the increase of biomass as the succession progresses. Note the well-defined vertical zonation in the climax. (Adapted from Eugene P. Odum, Fundamentals of Ecology *[Philadelphia: W. B. Saunders Company, 1959].)*

Test Yourself

1. Explain the meaning of limiting factors in an environment.
2. Plants need nitrogen, but cannot use the free nitrogen in the air. How do they get nitrogen?
3. What is meant by the nitrogen cycle? (Explain briefly.)
4. Where does most of the oxygen in the air come from? By what process?
5. How are bacteria in the soil and on certain plant roots important to plant and animal life?
6. When farmers cultivate a crop, in what main ways do they simplify the local ecosystem? What can happen as a result?
7. Why do ecologists speak of a carbon–oxygen cycle rather than of a carbon cycle and an oxygen cycle?
8. Do limiting factors operate separately, or together? Does any living thing seem to be affected by only one limiting factor? Explain.
* 9. In your town, are limiting factors the same for everything everywhere? Explain.
10. Can you think of any natural situations where a life community would have a sharp boundary—that is, where the limits of the ranges of all the different species would occur along the same line?
11. Compare the results of sudden freezing weather on (a) a natural ecosystem made up of many kinds of plants and animals; and (b) a field planted with only a single crop.
12. Why can people successfully raise chosen plants in fields or gardens, although those same plants may soon die out if left unattended?

* Extra Credit

Food webs - Food chains

Test Yourself

* 1. Why have food webs replaced food chains in this chapter's discussion?
2. Why do ecologists speak of food pyramids? What things are involved in them? What do these pyramids show?
3. What is biomass?
4. What advantage would people realize from living on one plant crop exclusively (or even just a few plant crops)?
5. What are the disadvantages for people of trying to live on one plant crop?
6. What are some natural remedies against soil erosion? Discuss briefly.
7. In physics, the second law of thermodynamics states that some energy is always lost whenever stored energy is changed from one form to another. Scientists call this a law because it happens unavoidably. How is this law related to observations we have made about the food web or pyramid?
8. An ancient Chinese proverb states that "each hill has only one tiger." Explain this saying in terms of what you have learned about the nature of food pyramids.
9. Explain how domestication of plants and animals made larger human populations possible.
10. What are the two main reasons why all the food eaten by organisms at one feeding level is not turned into body substance, or *biomass*, at that level?

* Extra Credit.

Vocabulary for photosynthesis

Glucose

Bonds

Visible spectrum

Absorption

Electromagnetic spectrum

Pigments

Hydrocarbon

Chloroplasts

Stroma

Grana

Upper epidermis

Stomata

Palisade layer

Lower epidermis

Spongy layer

Amine

Amino acid

Protein

Vocabulary for elemental cycles

Protoplasm

Sphere

Elements

Chlorophyll

Hemoglobin

Insulin

DNA - Deoxyribosenucleic acid

Fossil fuels

Carbon dioxide

Vocabulary for food chains, ecological pyramids, population growth, and succession of plants and animals

Food chain
Food web
Herbivore
Carnivore
Consumer
Producer
Insectivore
Succession
Calory
Pyramid of numbers
Pyramid of energy
Sigmoid curve
Environmental resistance
Biotic potential
Carrying capacity
Dynamic equalibrium
Exotic (Biological meaning)
Optimum
Primary succession
Secondary succession
Aquatic succession
Carbonic acid (H_2CO_3)
Biomass

List Of Ecological Tests To Be Taken At Intervals

1. Particulate count of the air.
2. Dissolved oxygen of water.
3. Biological oxygen demand.
4. Chemical pollutants in water.
5. Soil tests.
6. Suspended matter in water.
7. Acid rain test.
8. Pollutant effect of phosphates and nitrate kit.

Cons- Ecol

Name

Hour

Leaf cross-section

Elodea leaf

UNIT IV

WILDLIFE ABUSE AND DEPLETION

OBJECTIVES

OBJECTIVE - UNIT IV. The student will comprehend how American attitudes toward wildlife led to a history of abuse, depletion, and extinction of wildlife.

I. The student will associate and evaluate how past concepts and traditions formed attitudes towards the wildlife of this country.

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CONTENT OUTLINE

I. The attitudes of past generations towards wildlife revolved around:

A. A Judeo-Christian tradition that separated man from nature and sanctified his dominion over it.

B. A laissez-faire capitalistic order that encouraged irresponsible use of resources.

C. Weak institutions, including the federal government that seemed unwilling or unable to protect wildlife and habitat.

D. A heritage of opposition to any restraint on "freedom".

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. General discussion with emphasis on past attitudes compared with modern attitudes.		
III. "American Attitudes Toward Wildlife" article to be read in class for general discussion.	Article from "Wisconsin Natural Resources" magazine	
IV. Hand out - Endangered Species: "States Take A Hand"	Article from Newsweek copy placed at the end of this unit.	

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OBJECTIVES	CONTENT OUTLINE
	II. In the early 1870's national newspapers like the American Sportsman, Forest And Stream, and Field And Stream, did much to provide a means of communication among sportsmen. A. Many sportsman's clubs and associations were created. 1. Important concerns of these organizations were "game protection" and "fish culture". 2. A code of conduct developed that included proper etiquette in the field, give game a sporting chance and to possess an asthetic appreciation of the whole sport. III. In 1887 Theodore Roosevelt and George Bird Grinnell founded the Boone and Crockett Club. A. This was the first private organization to deal effectively with conservation issues on a national scope. 1. The club played all-important role in creation and administration of the first national parks, forest reserves and wildlife refuges. 2. These were also the formative years in Roosevelt's development as a future conservation leader.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION

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OBJECTIVES	CONTENT OUTLINE
II. The student will be introduced to the history of bison herd abuse for comprehension of the devastating effects it had on these animals.	I. The North American prairies in the late eighteenth century supported up to 60 million bison. A. Colonel R. I. Dodge standing at the summit of Pawnee Rocks in Arkansas, stated that he could see 6 to 10 miles in all directions and the entire panorama was "covered with buffalo". II. With the ending of the Civil War, a ruthless campaign of slaughter brought the bison to the brink of extinction. A. The U. S. Army believed that the defeat of the Plains Indians hinged on the destruction of the buffalo. 1. Between 1871 and 1872 about 8.5 million buffalo were slaughtered. 2. The westward extension of the railroad facilitated the butchery. a. Buffalo Bill Cody killed as many as 200 in one day to provide meat for the crews laying railroad tracks. B. Much of the buffalo body was wasted and many times the whole animal was left to rot. 1. In the winter of 1872-73 about 1.5 million hides were shipped to eastern markets and sold for $3.00 per hide. 2. Less than 1% of the meat was marketed. 3. Over 100,000 animals were killed for just their tongues. 4. Bone pickers collected skeletal remains and shipped them to fertilizer plants in Kansas and Minnesota. 5. The long facial hair was used for stuffing mattresses.
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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students II. General discussion with emphasis on past attitudes compared with modern attitudes. III. Question and answer periods	Overhead projector and transparencies	

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OBJECTIVES	CONTENT OUTLINE
	C. By 1889 only 150 bison survived in the wild. 1. The last wild buffalo was shot by a rancher in Park County, Colorado in 1894. D. A small herd has been built up from 250 animals that had been in captivity.
III. The students will be introduced to the history of waterfowl abuse for comprehesion of the devastating effects it had on waterfowl.	I. In 1849 the American wetlands supported an immense number of waterfowl. A. Captain Howard Stansburg explored the Bear River marshes of Utah in 1849. 1. He was amazed to see, "Thousands of acres, as far as the eye could reach seemed literally covered with them". B. Other explorers used phrases like "clouds of ducks" and "thunder like sounds" to indicate the waterfowl abundance. 1. The redhead duck occured in dense rafts, several miles long and numbering up to 50,000 birds. C. The waterfowl population began to dwindle due to: 1. Marsh and pothole drainage for agricultural purposes 2. Market hunters and so-called sportsmen a. live decoys and multiple-gun rigs were used b. a Maryland hunter used a 100 pound gun to slaughter and cripple large numbers of birds c. one sportsman killed 64 broadbill, 98 black ducks, and one gadwall in 4 hours

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students II. General discussion with emphasis on past attitudes compared with modern attitudes. III. Question answer period	Overhead projector and transparencies	

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OBJECTIVES	CONTENT OUTLINE
	d. a Connecticut hunter killed 127 birds in one day e. during the winter of 1893-1894, over 120,000 mallards were sent to market from Big Lake, Arkansas f. one Minnesota hunter slaughtered 6,000 ducks in one season D. Many thousands of ducks spoiled before they could be shipped to market and thousands of carcasses had to be disposed of.
IV. The student will be introduced to the history of the passenger pigeon for comprehension of how its extinction was brought about.	I. The passenger pigeon was once the most abundant bird on earth. A. Alexander Wilson, a renowned ornithologist, observed a migrating flock he estimated was one mile wide and 240 miles long and composed of 2 billion birds. 1. It took a number of hours for the flock to fly by. B. Not one living passenger pigeon is alive today. C. The following are the factors that contributed to the extinction of the passenger pigeon: 1. Many of the potential nesting and food trees were chopped down. 2. Disease may have taken its toll since breedi birds were susceptible to infectious-disease epidemics because they nested in dense colonies. 3. Many pigeons may have been destroyed by storms or by migration mistakes.
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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. General discussion with emphasis and past attitudes compared with modern attitudes.		
III. The hand out, "Hurricane Of Death" to be read in class.	Article, "Hurricane Of Death"	
IV. Discussion of the article.		

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OBJECTIVES	CONTENT OUTLINE
	4. Low biotic potential since the female produced only one egg. 5. The reduction of the flocks possible deprived these social birds the stimulus for mating and nesting. 6. The slaughter by the market hunters since pigeon flesh was considered both a delectable and fashionable dish.

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
177		178

OBJECTIVES	CONTENT OUTLINE
V. The student will list and comprehend the natural causes contributing to wildlife extinction.	I. The natural causes contributing to wildlife extinction are not created by man. A. Restricted range and habitat 1. The kirtland warbler has a breeding range of just 85 to 100 mile area in the north-central part of lower Michigan. 2. It nests only in jack-pine-barren habitat with trees ranging in age from 6 to 15 years and from 5 to 20 feet in height. a. only prescribed burning by the U. S. Forest Service keeps nesting areas suitable B. Low biotic potential 1. The female polar bear breeds only once every three years and then gives birth to only two cubs. 2. The female California Condor lays only a singl egg every other year. C. Genetic assimilation 1. The coyote, of which thousands exist, is crossing with the red wolf of which only 150 exist. D. Non-adaptive behavior 1. The Carolina parakeet, the only parrot native to the U. S., was destroyed because of a peculiar behavioral trait. a. if one member of a flock was shot down, the remaining birds would hover over the dying bird forming easy targets for hunters 2. These parakeets ravaged fruit orchards.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. General discussion with emphasis on natural extinction.		
III. Two hand outs to be distributed: a. Past and present extinction rates b. Extinct North American animals	The hand outs are located at the end of this unit.	
Conclusion: A. Review for test: 1. Attitudes toward wildlife 2. History of the bison herd 3. Waterfowl depletion 4. Passenger pigeon 5. Wildlife extinction		
B. A review sheet on this unit will be completed by all students.	Review sheet	Review sheet to be turned in.
C. Students will write out answers to problems 1-16 page 84 of the test.	Text	Papers will be turned in.
D. Test over this unit will be taken by the students.	Test	Test will be turned in for grading.

OBJECTIVES	CONTENT OUTLINE
	E. Specialized diet 1. The Florida Everglade kite feed only on snails that have become scarce. a. only ten individuals are left 2. Australia's koala bear feeds only on the leaves and buds of eucalyptus trees. F. The pet trade 1. The U. S. Fish and Wildlife Service determine that the pet trade imported: a. 74,000 mammals b. 200,000 birds c. 400,000 reptiles d. 140,000 amphibians e. 28,000,000 fish
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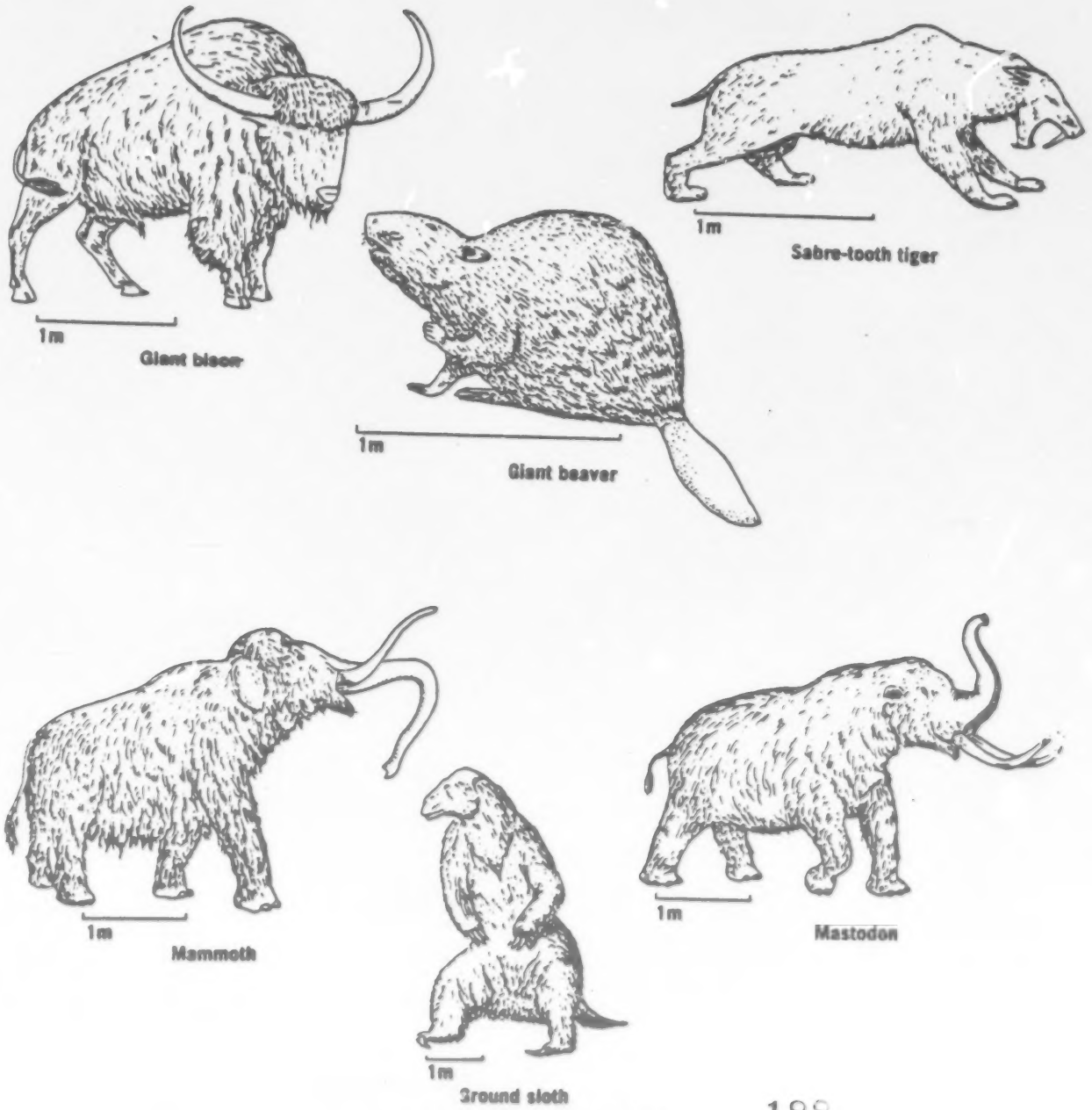
DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
	References: Oliver S. Owen, Natural Resource Conservation, An Ecological Approach Jonathan Turk, Introduction To Environmental Studies John F. Reiger, American Attitudes Toward Wildlife, Wisconsin Natural Resources	

Vocabulary for "Wildlife Abuse and Depletion" unit.

Judeo-Christian
Laissez-faire capitalism
Extinction
Habitat
Biotic potential
Genetic assimilation
Non adaptive behavior

PAST AND PRESENT EXTINCTION RATES

Year Span	Average Number of Years Required for Extinction of One Mammalian Species
1–1800	50
1801–1850	25
1851–1900	1.6
1901–1950	1.1
1951–2000	>1



Extinct North American animals.

UNIT V

WATER POLLUTION

OBJECTIVES

OBJECTIVE - UNIT V - The student will be aware of the various water pollutants of our environment and the control measures which minimize effects of these pollutants.

I. The student will be aware of the problem of water pollution.

CONTENT OUTLINE

I. Introduction To The Water Pollution Problem

A. North Americans have long prided themselves on the fine quality of their drinking water.

1. Travelers from North America are advised not to drink water in less well developed nations.

B. In many areas of the world, water purification systems are either inadequate or nonexistant.

C. In recent years the quality of drinking water in North America has been questioned.

1. Tap water in several American cities has a strong smell and poor taste.

D. Chemist analyzing water supplies have raised disturbing questions.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Discussion of the general problem in North America		
III. The results of chemical tests taken of Rock River should be reviewed.		
IV. Handout - "Cleaning The Rock" to be read in class.	Article from "Wisconsin Natural Resources" magazine	
A. Questions related to the article will be answered.		I. Questions and answers will be turned in.

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OBJECTIVES	CONTENT OUTLINE
II. Given a set of facts the student will be able to determine if a body of water is polluted.	I. How Is Water Pollution Defined? A. To a chemist water is pure when only water molecules are present and nothing else. B. Water can be usable for drinking if it has CO_2 gas, salts, minerals, and even a small amount of organic matter. 1. The body needs some of the minerals and others are harmless. C. Water is polluted when it is unfit for its intended use. 1. Water is polluted when: a. it cannot be used for drinking b. it cannot support fish and other aquatic organisms c. it cannot be used for swimming
III. The student will be able to list and explain the causes of water pollution.	I. Nutrient Pollution Of Inland Waters A. All animals and most plants require oxygen. B. In a natural system the quantity of oxygen and nutrients is delicately balanced. 1. An increase or decrease of any essential ingredient may upset the entire system. C. If sewage is introduced: 1. Plankton and algae will grow very fast in a population explosion. 2. Larger animals will not increase proportionally. 3. Microscopic organisms, small worms and larger "sludge worms", will grow rapidly. a. the result is less oxygen for all. b. those organisms first to die out will be the fish 4. The resulting condition is called "eutrophication".

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
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OBJECTIVES	CONTENT OUTLINE
	D. Sewage, farm fertilizers, and laundry detergents can cause "eutrophication" of an aquatic system. E. Many modern detergents contain phosphates. 1. Phosphates are an essential component of fertilizers. a. phosphates are also a limiting growth factor in aquatic environments 2. When detergents are discharged into waterways, they supply the needed element promoting rapid growth of algae and aquatic weeds. a. the explosive reproduction of these plants have caused interference with fishing, navigation, irrigation, and the production of hydroelectric power b. they have brought disease and starvation to communities dependent on these bodies of water 3. Examples of water weed problems are the water hyacinth in the Congo, Nile, and Mississippi Rivers, the waterfern in southern Africa, and the water lettuce of Ghana. F. An environmental impace could be eased if: 1. A combination of soap and washing soda was used (sometimes called sal soda). 2. Using low phosphate or non-phosphate detergents. 3. Use less detergent than the recommended amounts on labels. a. using 1/2 of the amount suggested on instruction labels will usually get clothes clean and save money
198	199

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture note taking by students	Overhead projector and transparencies	
II. Discussion of the general problem		
III. Hand out "PCB In Lake Michigan" to be read in class.	Article from "Wisconsin Natural Resources" magazine.	
A. Questions related to the article will be answered.		I. Questions and answers will be turned in.

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OBJECTIVES	CONTENT OUTLINE
III. The student will become aware of the relationship between water pollution and infectious diseases.	I. Sewage in an inland waterway may lead to depletio of oxygen and death of fish, but also may carry disease organisms. A. The diseases transmitted are usually due to micro organisms and parasites. B. Cholera can be transmitted by sewage. 1. It involves intense diarrhea resulting in massive fluid depletion and death. 2. In most developed nations water purificatio systems have destroyed most disease bacter 3. This disease is still common in Asia and particularly in India. C. Typhoid, viral infections such as hepatitis are carried by polluted water.
IV. The student will become aware of industrial wastes in water pollution.	I. Large quantities of water pollutants are released into streams and rivers from paper production, food processing, chemical manufacturing, steel production, and petroleum refining. A. Many large American cities obtain drinking water from nearby rivers. 1. New Orleans obtains its drinking water from the Mississippi. a. many thousands of factories lie north of the city discharging tons of foul daily into the river B. Many industrial pollutants can be processed o of drinking water but not all. 1. Some industrial pollutants are: a. Lead b. Mercury c. Benzene d. Arsenic e. Pesticide residues f. Hundreds of other mo in small concentrati
202	203

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - Note taking by students	Overhead projector and transparencies	
II. Question - answer period		
III. European problem of water born diseases and parasites will be discussed.		
IV. Discuss handout on water purification.	This handout is located at the end of this unit.	
I. The students will read pages 272 to 274 from text Introduction To Environmental Studies.	Text - Introduction To Environmental Studies	
II. Lecture - Note taking by students	Overhead projector and transparencies	
III. Discussion of the general problem		
IV. Question - answer period		
V. Handout - The use of groundwater by 23 industries in the U.S.	This handout is located at the end of this unit	

OBJECTIVES	CONTENT OUTLINE
V. The student will become aware of the pollution of the oceans.	I. Oil spilled into the ocean is one source of pollution. A. Between 1969 and 1974, there were 500 tanker accidents that involved oil spills. 1. More than one million metric tons of oil escaped. B. Another source of oil involves the cleaning of ship's holds with seawater. 1. About 80 to 90 percent of oil dumped into the oceans is from this source. a. this cleaning is usually done at night II. Chemical wastes are another source of pollution. A. Poisonous chemical wastes are difficult to dispose of B. The ocean is a tempting area for dumping. 1. Chemical wastes are sealed in drums and later dumped out to sea. a. of course the drums will eventually rust through III. There is an overall threat to life in the sea. A. In ocean regions near large cities, pollution has killed most marine life. 1. Example - New York City, U. S. A. 2. Example - Minamata Bay, Japan B. Sometimes natural systems are amazingly stable 1. Thousands of tons of crude oil have been dumped in mid-ocean only to disappear in a few months.

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. The students will read pages 274 to 277 from the text, Introduction To Environmental Studies.	Text - Introduction To Environmental Studies	
II. Lecture - note taking by students	Overhead projector and transparencies	
III. Discussion of the general problem		
IV. Question - answer period		
208		209

OBJECTIVES	CONTENT OUTLINE
	C. The poisons that accumulate in the ocean have no place to go, it is their ultimate resting place. D. All of the worlds rivers with outlets to the ocean pollute it. E. Fisheries, a valuable food supply, may be destroyed.
VI. The student will recognize and evaluate the Federal Water Pollution Control Act of 1972.	I. The Law Stated: A. Whenever possible, water quality should be clean enough for swimming, recreation, and healthy growth of fish and wildlife by July 1983. B. By 1983 there must be zero discharge of industrial and domestic wastes into U. S. waters. C. Congress later extended the deadline to 1984. II. The cities, towns, agriculture, and industry use about 1.5 trillion liters of water every day. A. If all this liquid was purified for drinking the cost would be prohibitive. B. Considerable quantities of water could be saved simply by wasting less. 1. Water could be reused 2. Water for lawns and toilets does not have to be purified drinking water. 3. Waterless toilets have been developed.
210	211

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. The students will read pages 277 - 278 from the text, Introduction To Environmental Studies II. Discussion of the general problem. III. Question - answer period Conclusion: A. Review for test: 1. Water pollution - general 2. Water pollution determination 3. Causes of water pollution 4. Water pollution and diseases 5. Industrial water pollution 6. Pollution of the oceans	Text, Introduction To Environmental Studies	

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OBJECTIVES	CONTENT OUTLINE
214	215

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
B. A review sheet on this unit will be completed by all students.	Review sheet	Review sheet will be turned in.
C. Students will write out answers to problems 1 - 16 page 282 from text.	Text, Introduction To Environmental Studies	Papers will be turned in.
D. Test over this unit will be taken by the students.	Test	Test will be turned in for grading.
	References: Jonathan Turk, Introduction To Environmental Studies Oliver S. Owen, Natural Resource Conservation An Ecological Approach Michael Glassman, Pollution Of The Environment, Can We Survive? Amos Turk, Jonathan Turk, Janet T. Wittes, Ecology, Pollution, Environment Lawrence W. McCombs, Nicholas Rosa, What's Ecology? Charles W. Lavaroni, Patrick A. O'Donnell, Lawrence A. Lindberg, Water Pollution	

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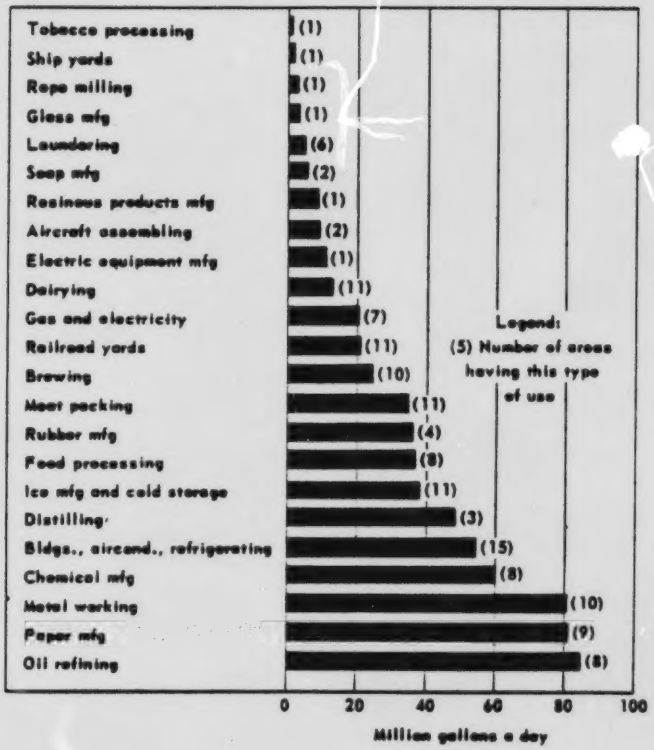
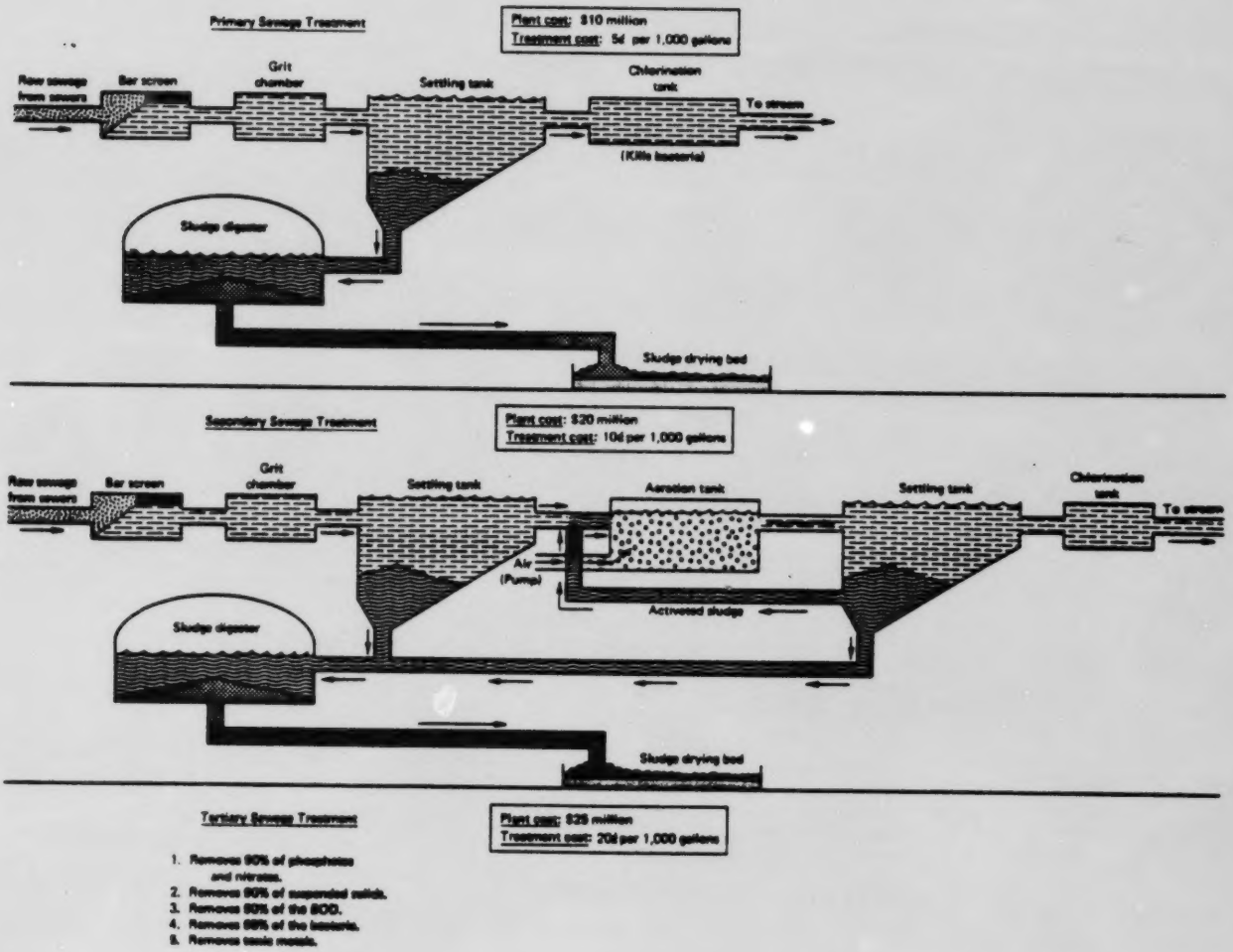
The use of ground water by industry in the United States



Three methods or levels of sewage treatment



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UNIT VI

AIR POLLUTION

OBJECTIVES

OBJECTIVE - UNIT VI - The student will be aware of the various atmospheric pollutants of our environment and the control measures which minimize the effects of these pollutants.

I. The student will be able to list causes and effects of air pollution.

CONTENT OUTLINE

I. Composition Of The Atmosphere:

A. The atmosphere is a mixture of:

1. Nitrogen gas - 78.09% by volume
2. Oxygen gas - 20.94% by volume
3. Carbon Dioxide - .03% by volume
4. Methane - .0001% by volume
5. Inert gases (mostly argon) - .93% by volume

B. Natural pollutants

1. Oxides of Nitrogen - .00005% by volume (mostly N_2O and NO_2)
2. Ozone (O_3) - .000002% by volume
3. Carbon Monoxide - .00003% by volume

C. Natural air also contains:

1. Water vapor
2. Dust (particulate matter)

II. Sources Of Air Pollution

A. Stationary combustion sources

1. Primitive people burned wood in caves and at camp sites.
2. The burning of coal, natural gas, and petroleum since the beginning of the industrial revolution added pollutants to the environment.

a. coal burning produces carbon dioxide
b. petroleum burning produces carbon dioxide and water

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Discussion of natural air and natural pollutants.		
III. Review handout, Atmospheric Anatomy.	This handout will be found at the end of this unit.	
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Discussion of the general problem of air pollution		
III. Review handout showing: A. The composition of clean dry air B. Total emissions of carbon monoxide C. Sources of pollution	This handout will be found at the end of this unit.	
IV. A question - answer period with the students as a review.		

OBJECTIVES	CONTENT OUTLINE
	3. The burning of these fuels produce fly ash pollutants in the case of coal, and sulfur dioxide (SO_2) and sulfur trioxide (SO_3) in the case of both coal and petroleum. a. high sulfur trioxide (SO_3) has been associated with the formation of sulfuric acid (H_2SO_4) and acid rain. 4. When fossil fuels are not burned completely carbon monoxide gas is produced instead of carbon dioxide. B. Industrial and transportation caused pollution. 1. By 1900 many industrial cities were heavily polluted. 2. The burning of coal was cause number one. a. others were steel manufacturing, copper smelting, etc. 3. The air became dark and soot from many sources made everything it settled on black. 4. The region of Los Angeles possessed very clear air since coal for heating etc. was not required. a. later after World War II automobiles deteriorated the regions atmosphere b. the Los Angeles smog is produced when automobile exhause is exposed to sunlight 5. The chemical manufacturing industries a. an automobile produces air pollution when it is driven b. air pollution is also released when the automobile is manufactured c. pollution is created when metals are mined d. more pollution is created when ores are smelted, and when metals are refined, molded, and mixed.
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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION

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OBJECTIVES	CONTENT OUTLINE
	6. Air pollutants are released when paints, plastics, glass, and chemicals are manufactured. 7. Oil refineries discharge smoke, soot, and gasses into the atmosphere. III. The Meteorology Of Air Pollution A. Atmospheric conditions determines how fast air pollutants are dispersed. B. A condition called atmospheric inversion can prevent the rapid dispersal of air pollutants. 1. A layer of warm air accumulates just above a city. 2. Pollutants from factories and automobiles cannot rise above the warm air layer because the layer of air is just as warm as the pollutants. 3. All of the pollution remains trapped and rests close to the ground. a. In this case the pollution accumulates until the air is unhealthy to breathe. IV. The Effects Of Air Pollution On Human Health A. Air pollution in Donora, Pennsylvania, in 1948 caused: 1. Twenty deaths 2. Six thousand illnesses B. Air pollution over London in 1952: 1. This was caused by a series of inversions. 2. The accumulated pollution was trapped for about three weeks. 3. About 4,000 deaths resulted. 4. Many thousands more became ill.

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Class discussion of the general problem.		
III. "Acid Rain" lab	The lab sheet and instructions will be found at the end of this unit.	The lab sheet with results will be turned in.
IV. The "Dust Fall" lab could be reviewed or the lab done again.	The lab sheet will be found at the end of Unit II.	
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Class discussion of the general problem with emphasis on: A. Donora, Pennsylvania B. Los Angeles smog C. London smog		

OBJECTIVES	CONTENT OUTLINE
233	C. Studies indicate that lung diseases are more prevalent in cities than in rural settings. D. Studies show that polluted urban air is directly harmful to the health of people with previous history of heart disease. E. Studies also show that polluted air is harmful to healthy people. V. The effects of air pollution on plants, animals, and materials. A. Air pollution has caused widespread damage to trees, fruits, vegetables, and ornamental flowers 1. The total cost damage in the United States has been estimated at one billion dollars per year. B. Plant damage by photochemical smog can: 1. Bleaches and glazes spinach, lettuce, chard, alfalfa, tobacco, and other leafy plants. C. Ethylene from automobile and diesel exhaust: 1. Makes carnation petals curl inwards 2. Ruins orchids by drying and discoloration D. North American livestock have been poisoned by air borne pollution such as: 1. Fluorine 2. Arsenic E. Air pollutants can cause extensive damage to materials. 1. Sulfieds blacken paint. 2. Ozone (O_3) causes natural rubber to crack. 3. Sulfur trioxide can become sulfuric acid, (H_2SO_4), to corrode metal and stone.

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Class discussion of the general problem		
III. Demonstration of ozone production.	Use a Wimhurst electric spark machine so that the students can smell the odor of ozone	

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OBJECTIVES	CONTENT OUTLINE
	VI. Depletion Of The Ozone Layer A. The sun emits an entire spectrum of light including ultra-violet. 1. Ultra-violet can damage living things. B. High energy UV is removed in the upper atmosphere by ozone (O_3). 1. Various air pollutants can destroy the ozone blanket. a. freon compounds in aerosol spray cans and nitrogen oxides produced by high flying jet aircraft can destroy ozone.

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students II. Class discussion of the general problem. A. Emphasize the molecular difference between ozone and regular atmospheric oxygen. B. Determine if substitutes could be used for Freon Propellent.	Overhead projector and transparencies	

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OBJECTIVES	CONTENT OUTLINE
II. The students will recognize and evaluate the Federal Clean Air Act of 1963.	I. This legislation was aimed at reducing pollution from automobiles and stationary sources. A. Seven years later in 1970, an amendment to the Clean Air Act required that there be a 90% reduction of automotive pollution by 1975. 1. Due to automotive industry resistance, such as the president of General Motors, the deadline was moved to mid 1980.

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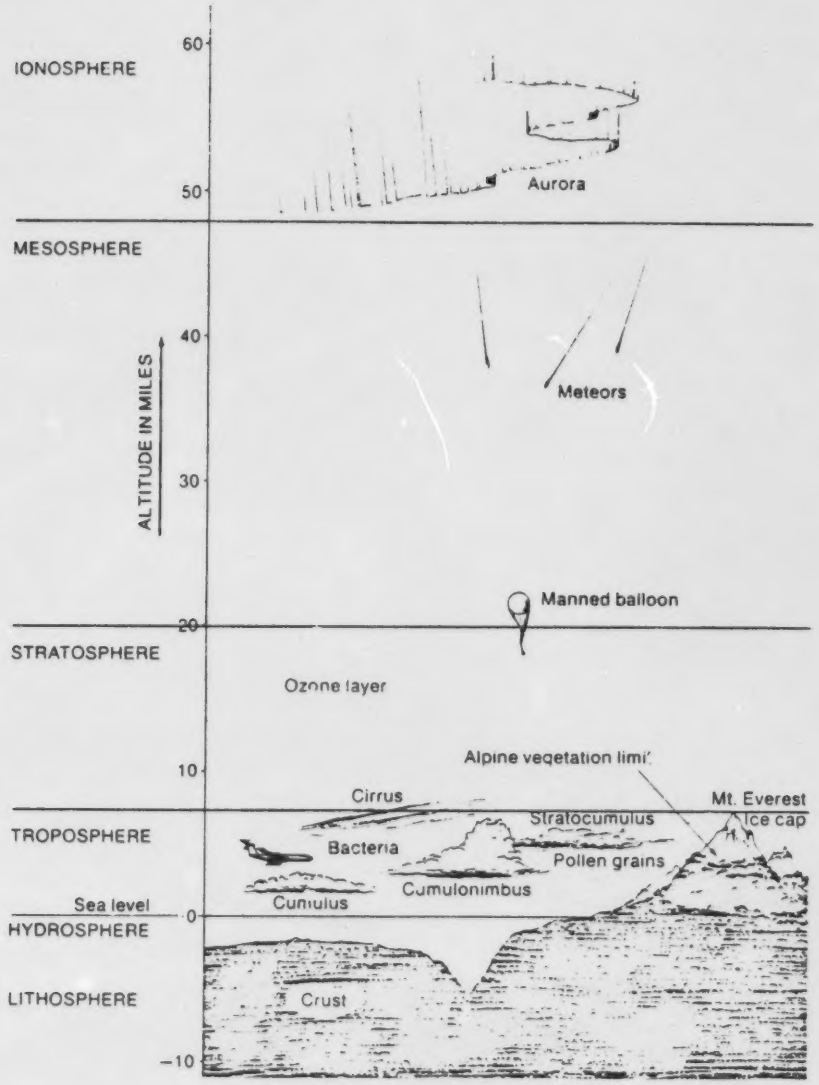
DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Class discussion of the Federal Clean Air Act of 1963. A. What are some of the local effects? B. Have electrostatic precipitators been installed on power plants around Beloit? C. Discuss local sources of air pollution. Conclusion: A. Review for test: 1. Composition of atmosphere 2. Sources of air pollution 3. Meteorology of air pollution 4. The effects of air pollution on human health. 5. The effects of air pollution on plants, animals, and materials. 6. Depletion of the ozone layer 7. Federal Clean Air Act Of 1963		
B. A review sheet on this unit will be completed by all students.	Review sheet	Review sheet will be turned in.

OBJECTIVES	CONTENT OUTLINE
245	246

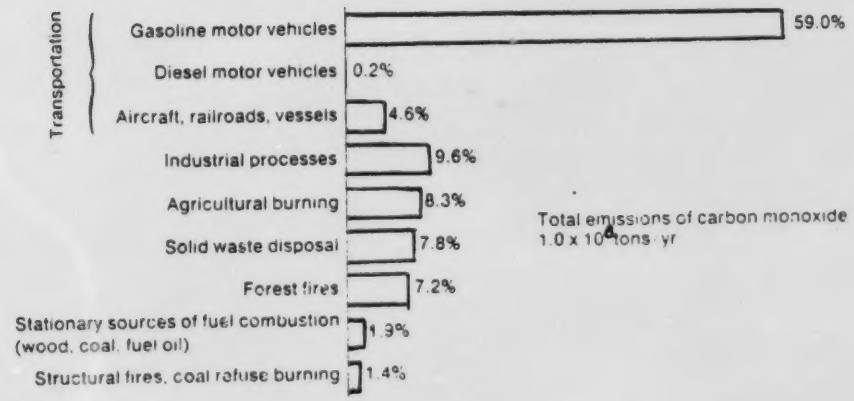
DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
C. The students will write answers to problems 1 - 14 page 264 of the text.	Text	Papers will be turned in.
D. The students will write out a brief statement for each vocabulary term at the end of this unit.	Vocabulary list will be found at the end of this unit.	Vocabulary list will be turned in.
E. A test over this unit will be taken by all students.		Test will be turned in for grading.
	References: Jonathan Turk, Introduction To Environmental Studies Oliver S. Owen, Natural Resource Conservation, An Ecological Approach William A. Andrews, Donna K. Moore, Alex C. LeRoy, Environmental Pollution Michael Glassman, Pollution Of The Environment Can We Survive? Amos Turk, Jonathan Turk, Janet T. Wittes, Ecology, Pollution, Environment	

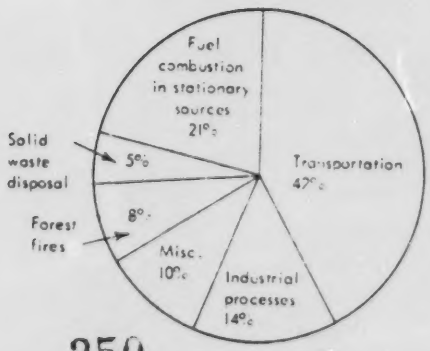
Atmospheric Anatomy



THE COMPOSITION OF CLEAN, DRY AIR

Gas	Percent by volume
Nitrogen (N_2)	78%
Oxygen (O_2)	21%
Argon (Ar)	0.94%
Carbon dioxide (CO_2)	0.03%
Helium (He)	0.01%
Neon (Ne)	0.01%
Xenon (Xe)	0.01%
Krypton (Kr)	0.01%
Methane (CH_4)	trace
Ammonia (NH_3)	trace
Hydrogen sulfide (H_2S)	trace
Carbon monoxide (CO)	trace
Nitrous oxide (N_2O)	trace





Acid Rain

Name

Date of collection ___

Location of test sample ___

City ___

Clean one baby food jar and cap.

Collect a sample of rain water at your home. Make sure the collecting jar does not receive water from a roof or tree.

pH reading _____

Vocabulary for "Air Pollution Unit"

Atmosphere

Air

Fly ash

Sulfur dioxide

Sulfur trioxide

Nitrogen oxide

Nitrogen dioxide

Carbon monoxide

Soot

Photochemical smog

Meteorology

Atmospheric inversion

Freon

Clean Air Act

UNIT VII

NUCLEAR ENERGY AND THE ENVIRONMENT

OBJECTIVES

OBJECTIVE - UNIT VII - The student will be able to comprehend the field of nuclear energy and its effects on the environment and become aware of the important and dangerous role radioactivity plays.

I. The student will be able to recognize the difference between natural radioactivity and artificial radioactivity.

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CONTENT OUTLINE

I. Natural Radioactivity
   - A. Discovery of radioactive materials
     1. Henry Becquerel and his photographic film
     2. Madam Curie and Pierre Curie discoveries of radioactive elements
        - a. pichblend
        - b. thorium
        - c. radium
   - B. The causes of radioactivity
     1. Changes in the unstable nuclei
   - C. Types of radiation
     1. Alpha particle (a)
        - ⊕⊕ Protons
        - ⊘⊘ Neutrons
     2. Beta particle - a high speed electron (B)
     3. Gamma ray - powerful radiations similar to light waves (y)
   - D. Transmutation of elements
     1. helium + nitrogen $\longrightarrow$ oxygen + hydrogen

        $^{4}_{2}HE + {}^{14}_{7}N \longrightarrow {}^{17}_{8}O + {}^{1}_{1}H$

     2. Elements can be changed to other elements

II. Artificial Radioactivity
   - A. Transmutation of elements
     1. Rutherford's experiments with radium and nitrogen
     2. Einstein's ideas of mass energy relationship ($E = mc^2$)

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students. II. Discussion of natural and artificial radioactivty. A. Emphasis should be placed on how an element can transform itself into another. III. Discussion of the present debate about the desirability of nuclear power systems.	Overhead projector and transparencies	

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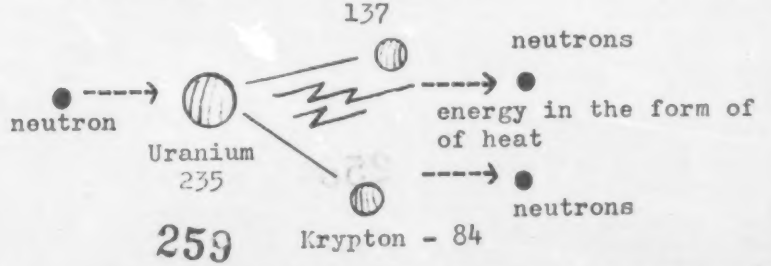
OBJECTIVES	CONTENT OUTLINE
	B. Atomic bullets to bombard elements for transmutation 1. Nuclei of light elements 2. Neutrons 3. Protons
II. Given the half-life of an element, the student will be able to compute the amount of the element present after a certain amount of time.	I. The Disintegration Of Elements A. The rate of disintegration cannot be altered 1. Melting, freezing, chemical changes does not change the set rate. B. Each radioactive element has its own half-life. 1. Uranium U^{238} - 4,500 million years 2. Thorium Th^{234} 24 days 3. Radium Ra^{226} 1,600 years
III. The student will develop an understanding of nuclear fission reactors.	I. Nuclear Fission Reactors A. Only certain nuclei of unstable atoms are fissionable 1. Uranium - 235 2. Plutonium - 3. Thorium - B. For fission to occur the nucleus must absorb a neutron.



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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - note taking by students	Overhead projector and transparencies	
II. Worksheet dealing with half-life problems will be passed out for student practice.	Worksheet with half-life problems.	This worksheet will be turned in.
III. Handout of half-life table.	This handout will be located at the end of this unit.	
I. Lecture - notetaking by students	Overhead projector and transparencies	
II. Class discussion on fission A. Emphasize the fact that the usable energy is the heat developed. B. Emphasize the difference between fission and fusion. C. Emphasize the similarities between a nuclear reactor power plant and a conventional coal fired plant.		

OBJECTIVES	CONTENT OUTLINE
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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
III. Handouts A. The pressurized power reactors B. Fossil fuel power plant and a nuclear power plant. C. A diagram showing nuclear fission chain reaction.	These handouts will be located at the end of this unit.	
IV. Class discussion on the two types of cooling systems now used. A. Handout showing two types of cooling towers. B. Handout showing water being returned to a lake or stream.	These handouts will be located at the end of this unit.	
V. Nuclear Energy - Sound filmstrip Study Guide	Filmstrip, Nuclear Energy Educational Materials and Equipment Co. New Rochelle, New York 10801 Film - sound projector	

OBJECTIVES	CONTENT OUTLINE
	1. The uranium splits: a. A great deal of heat is released. b. Barium and Krypton are formed. c. Two neutrons are released to smash two other $_{U}235$ nuclei. 2. If enough $_{U}235$ is present and concentrated a chain reaction will occur. a. If this chain reaction occurs rapidly, an explosion will result. b. If it occurs slowly, a sustained amount of heat will be released. C. Only about 2% of U^{235} is used to produce a nuclear reaction. 1. The rest of the fuel rod is composed of non-fissionable $_{U}238$. D. Not enough U^{235} is present to create a nuclear explosion.
IV. The student will be able to identify the safety problems related to the production of nuclear energy.	I. Safety In A Nuclear Fission Reactor. A. A reactor, as mentioned before, cannot blow up like an atomic bomb. 1. Not enough U^{235} is present to create an atomic explosion. B. Control rods of cadmium or boron which control the speed of the reaction by being pushed between and being withdrawn from the fuel rods could be damaged. 1. This could possibly cause control problems. 2. They control the speed of reaction by absorbi neutrons.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes	Overhead projector and transparencies.	
II. Class discussion on safety aspects of nuclear power plants. A. Emphasize the importance of water cooling and back-up cooling systems B. Emphasize the control rod mechanism C. Emphasize the ultimate disaster (China Syndrom)		

OBJECTIVES	CONTENT OUTLINE
	C. The critical cooling of the reactor is done with water. 1. If the cooling water system malfunctions, the temperature would rise to 1480°C in 45 seconds. 2. At this temperature the water left in the reactor core would react with materials in the fuel rods creating explosive hydrogen gas. D. If the cooling system fails, a back-up system would take over. 1. A back-up supply of water is provided. E. If the emergency cooling system fails then: 1. The temperature would rise until the fuel rods melt. 2. In a few hours the concrete shell surrounding the reactor core will break and tons of white hot radioactive material will melt its way into the ground. a. The "China Syndrome" F. The problem of radioactive waste disposal concerns half-life. 1. U^{235} has a half-life of 700 million years. 2. Many of the fission products have half-lives measured in centuries, years, months, and seconds. 3. There is no way to speed up or slow down the reaction. 4. The radioactive waste created today will have to be cared for by thousands of future generations.

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DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
III. Hand-out - The control rod mechanism IV. Review the events that resulted into the "Three Mile Island" problem.	This handout is located at the end of this unit.	

OBJECTIVES	CONTENT OUTLINE
V. The student will develop an understanding of the fission-breeder reactor.	I. The breeder reactor produces more fuel than it uses. A. The fuel U^{235} must be more concentrated in a breeder than in a conventional reactor. B. The abundant U^{238} in a fuel rod is converted to a plutonium - 239. 1. Plutonium is a fission fuel and can thus be used instead of the rare U^{235}. 2. Plutonium is a very dangerous health hazard. a. It's half-life is 24,000 years.
VI. The student will develop an understanding of nuclear fusion reaction.	I. Fusion reactions occur when light elements are drive together to form heavier elements. A. Isotopes of hydrogen will fuse if fired at each other at very high speeds. 1. This is the reaction of our sun and the hydrogen bomb. B. A great deal of heat energy can be released. C. To initiate fusion, the temperature must be raised to a minimum of 40 million degrees Celsius. 1. It is impossible to build a container to withstand these temperatures. 2. A "magnetic bottle" may be the answer. 3. High intensity laser beam: are being worked with to create the correct temperature. D. What are some of the advantages of a fusion reactor? 1. Energy would become extremely abundant.

DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
I. Lecture - students take notes	Overhead projector and transparencies.	
II. Class discussion A. Mention the nuclear power breeder reactors in Europe.		
III. Energy Alternatives - Sound Filmstrip Study Guide	Energy Alternatives Educational Materials and Equipment Co. New Rochelle, New York 10801 Film - sound projector	
I. Lecture - students take notes	Overhead projector and transparencies.	
II. Class discussion with emphasis the effects on a society with practical fusion reactor energy source.		
III. Solar Energy - Sound Filmstrip Study Guide	Solar Energy Filmstrip Educational Materials and Equipment Co. New Rochelle, New York 10801 Film - sound projector	
Conclusion A. Review for test 1. Natural and artificial radioactivity 2. Half-life 3. Fission reactors 4. Safety problems 5. Fission breeder reactor 6. Fusion reactor		

OBJECTIVES	CONTENT OUTLINE
	2. If the reactor gets out of control, the temperature would automatically go down and the reaction would stop. 3. The problem of radioactive waste would be much simpler.

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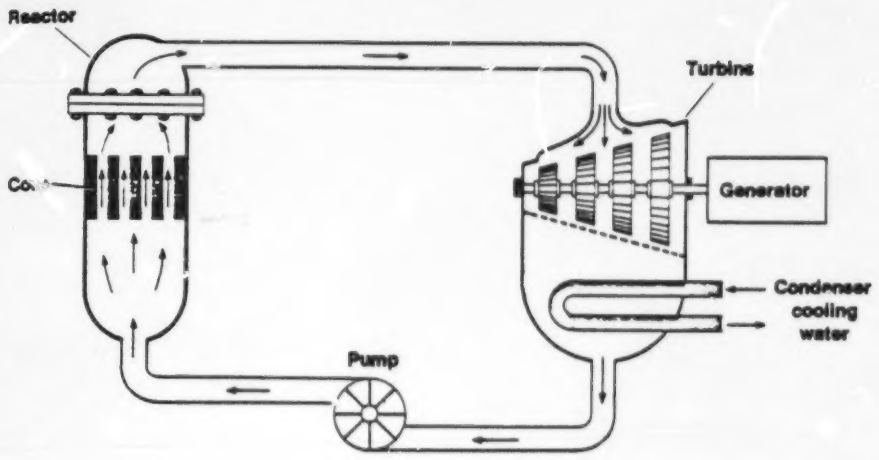
DAILY PROCEDURES	REFERENCES and MATERIALS USED	EVALUATION
B. A review sheet on this unit will be completed by all students.	Review sheet	The review sheet will be turned in.
C. The students will write out the answers to problems 1-19, page 193-194 of the text.		The answers will be turned in.
D. The student will write out a brief statement for each vocabulary term at the end of this unit.	Vocabulary list will be found at the end of this unit.	Vocabulary list will be turned in.
E. A test over this unit will be taken by all students.		Test will be turned in for grading.
	References: Jonathan Turk, Introduction to Environmental Studies Oliver S. Owen, Natural Resource Conservation, An Ecological Approach William A. Andrews, Donna K. Moore, Alex C. Leroy, Environmental Pollution Ernest Burkham, Stewart P. Darrow, David D. Redfield, William R. Snyder, Environmental Science George R. Tracey, Harry E. Tropp, Alfred E. Friedl, Modern Physical Science	

Radioactive Decay Table For $^{238}_{92}U$ — Half-life

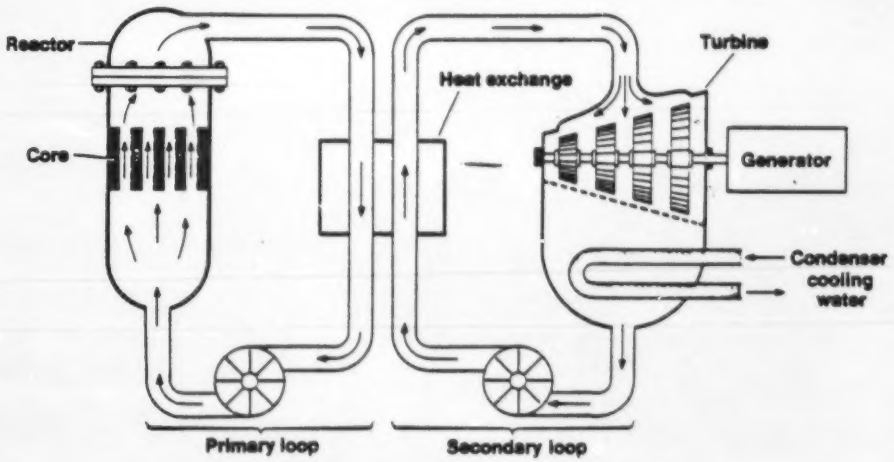
Element	*Atomic number*	*Mass number*	*Particle given off*	*Half-life*
Uranium	92	238	Alpha	4,500 million years
Thorium	90	234	Beta	24 days
Protoactinium	91	234	Beta	1.1 minutes
Uranium	92	234	Alpha	250,000 years
Thorium	90	230	Alpha	80,000 years
Radium	88	226	Alpha	1,600 years
Radon	86	222	Alpha	3.8 days
Polonium	84	218	Alpha	3 minutes
Lead	82	214	Beta	27 minutes
Bismuth	83	214	Alpha or Beta	20 minutes
Polonium	84	214	Alpha	0.001 second
Thallium	81	210	Beta	1.3 minutes
Lead	82	210	Beta	20 years
Bismuth	83	210	Beta	5 days
Polonium	84	210	Alpha	140 days
Lead	82	206	–	stable



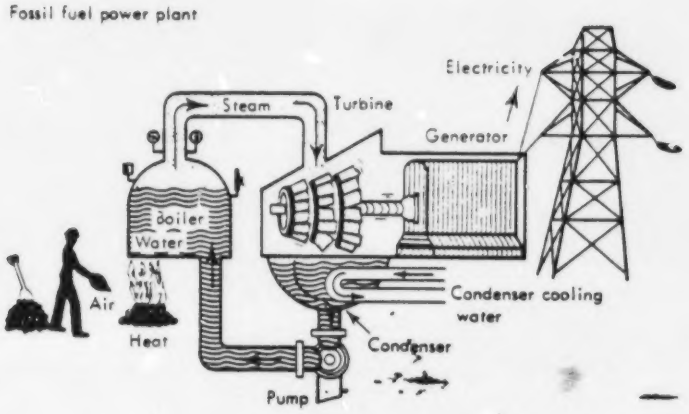
In the one-loop system, the liquid or gas heated by the radioactive core of the nuclear reactor is used directly to drive the turbine.

The *pressurized-water reactor.* This is somewhat different from the boiling-water reactor, although the temperature is about the same (600°F). With the pressure in this system increased to 2000 pounds per square inch, the water cannot boil. Pressurized water carries more heat than steam at the same temperature. It does not drive the turbine generator directly, but heats water in a second loop, producing the steam necessary to drive the turbines. See Fig. 8-10.

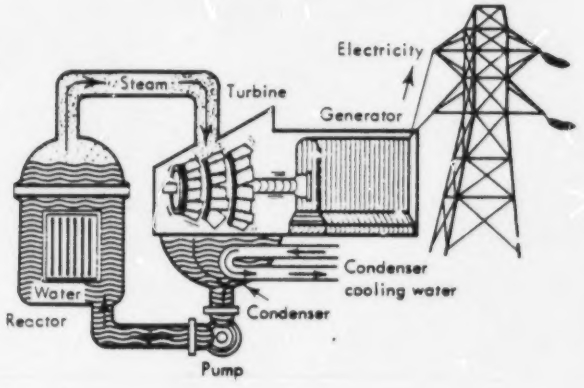
In a two-loop system, the liquid or gas heated by the core of the nuclear reactor is kept away from the turbine. Instead, it heats steam in a second loop. This system safeguards the power plant from radioactive contamination in case of accident.



Fossil fuel power plant

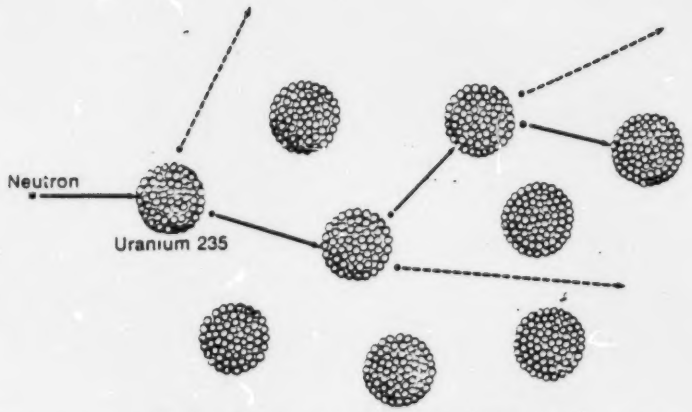


Nuclear power plant- boiling water reactor (BWR)



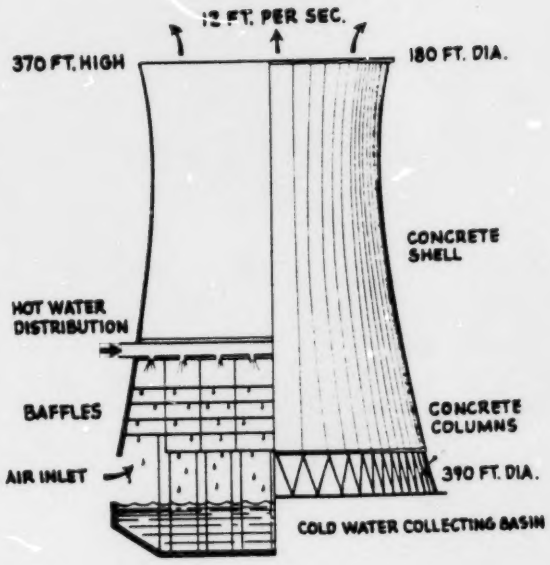
Comparison of cooling systems for fossil-fuel power plant and nuclear power plant (boiling water reactor).

Nuclear Fission

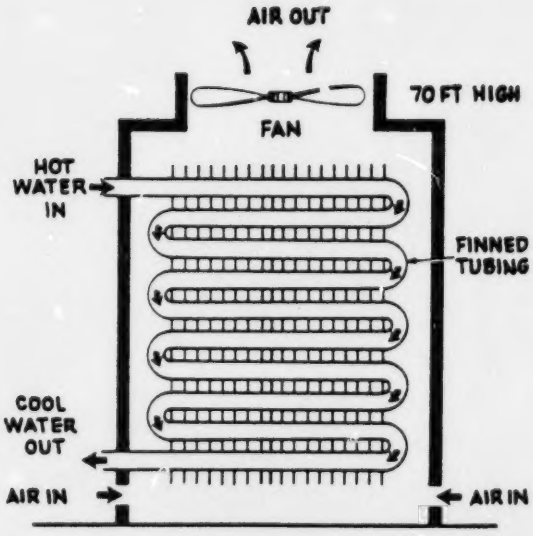


The fuel for a nuclear reactor contains only a small concentration of uranium-235 atoms. Therefore many neutrons escape without hitting a uranium-235 nucleus. The reaction continues in a controlled fashion and cannot blow up like a bomb.

Two types of cooling towers.

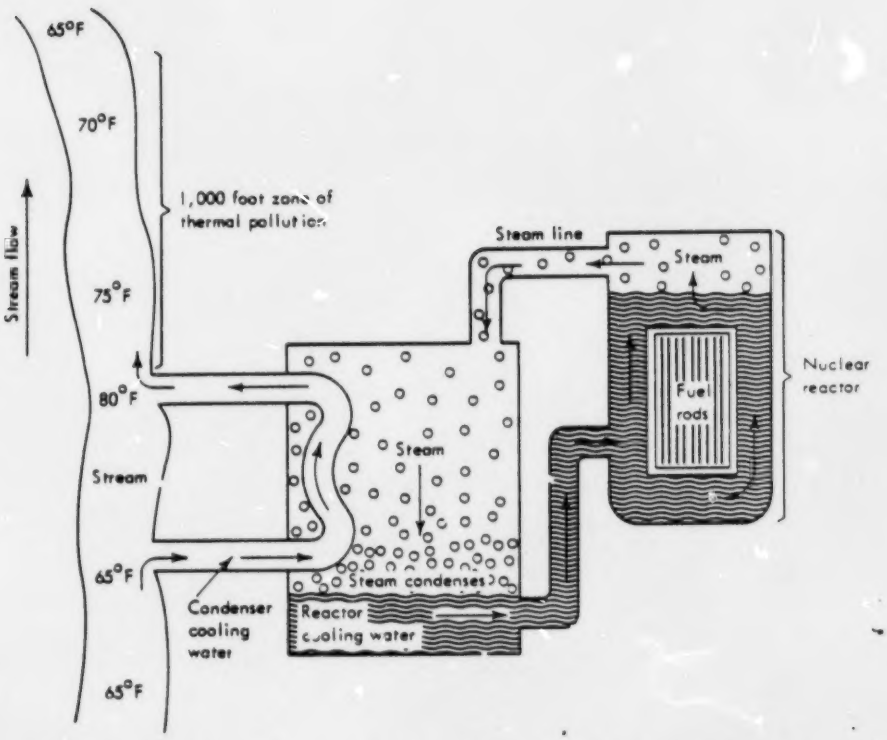


Natural-draft, on "wet," cooling tower removes heat from condenser water by evaporation on direct contact with air rising up through the hollow concrete shell. Its large size is necessary to provide sufficient surface area and draft to cool thousands of gallons of water each day. The distinctive shape channels the airflow and yields great structural strength with less material.



Dry cooling tower, which works very much like a large automobile radiator. It is 3 times as expensive as the wet cooling tower. Rather than evaporation, cooling takes place as large currents of air are drawn over finned tubing through which hot water circulates. To date, the only installation of any size is at a 200,000-kilowatt power plant in South Africa. This is far too small for use at today's 1-million-plus-kilowatt generating stations.

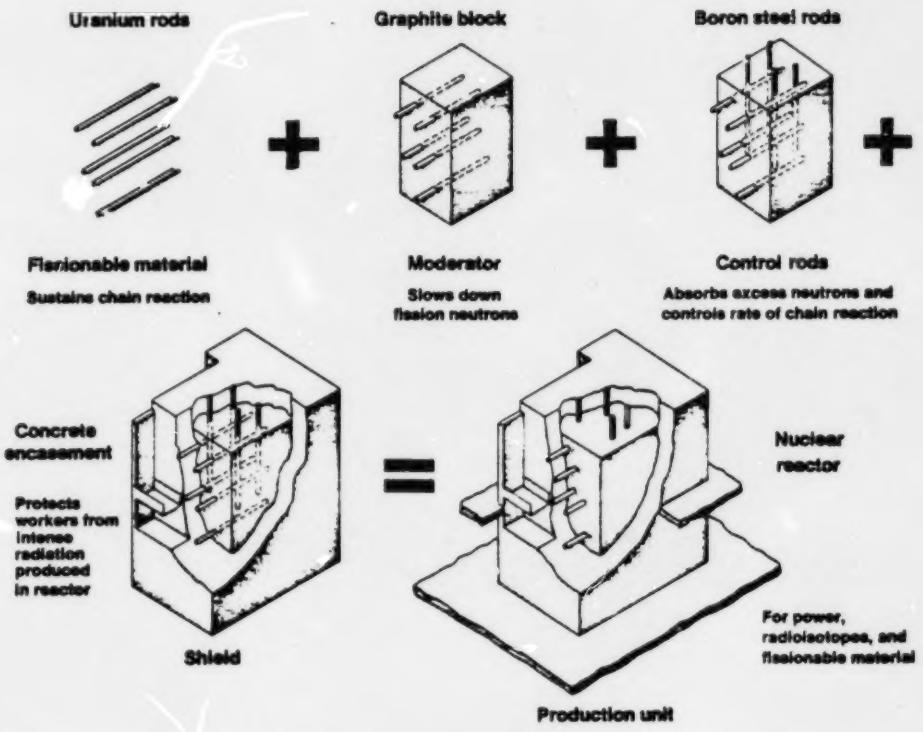
Cooling reactor system using a river or lake.



Nuclear Reactor Cooling System. Note the 1,000-foot zone of thermal pollution caused by the discharge.

A nuclear reactor pile showing the position of control rods.

The parts of a nuclear reactor or pile.



Vocabulary for "Nuclear Energy and the Environment" unit

Radioactivity
Beta particle
Alpha particle
Gamma ray
Half-life
Transmutation
Isotope
Nucleus
Proton
Neutron
Nuclear fission
Chain reaction
Nuclear fusion
Breeder reactor
Atomic Bullets
Control rods
China syndrome
Atomic Weight
Magnetic bottle
Laser beam